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SCIENTIFIC FREEDOM AND SECURITY

THE Stevenson Lecture which Dr. J. B. Conant delivered at the London School of Economics and Political Science on March 17 has now been published* under the title "Anglo-American Relations in the Atomic Age". It is important both for some suggestions for co-operation which deserve close consideration by the man of science as well as by the administrator and politician, and as a contribution to Anglo-American understanding. Dr. Conant recognizes that Great Britain can help the United States to preserve the conditions of academic integrity and freedom upon which scientific advance largely depends—but only if we attempt to understand conditions in the United States. Equally he recognizes the need for the same attempt at understanding on the part of the United States in regard to what appear to be weaknesses in British security measures and policy.

If Dr. Conant's lecture contributed solely to sufficient understanding to restrain scolding on either side and stimulate counsel instead, he would earn the thanks of men of science generally. His lecture should equally stimulate constructive thought about the real issues—the thinking that is an essential preliminary to the working out of any means of giving effect to the practical suggestions he makes. We are left in no doubt as to the practical difficulties with which international co-operation in such matters as nuclear energy bristles, particularly through the natural reluctance of any nation to enlarge its security risk by divulging secrets of such transcendent importance even to its allies. That difficulty would remain, even if so many scientists everywhere were not genuinely opposed to any restriction of the traditional freedom of publicity in science and if none had communist sympathies.

The heart of Dr. Conant's address lies, in fact, in its frank discussion of some of the factors which at present adversely affect Anglo-American relations and of the means by which those factors may be overcome. He does not claim to be unbiased in this discussion, for at the outset he admits that, to his mind, good Anglo-American relations were never more important nor more difficult to achieve than at present. Accurate information and informed interpretation, however, are the right counter to the efforts of those who from private or subversive motives seek to sow discord between the English-speaking nations, and in this address Dr. Conant's sympathies with Great Britain have manifestly not prevented him from approaching his subject on rational lines, or from seeing it in the wider perspective.

Most men of science are only too well aware of the extent to which the position of science in international relations has deteriorated over the past hundred or even fifty years. Not so many appreciate the extent to which, as Dr. Conant also reminds us in this lecture, statesmen and politicians are handicapped

* Anglo-American Relations in the Atomic Age. By Dr. James B. Conant. (Delivered on 17 March 1952 at the London School of Economics and Political Science.) Pp. 42. (London: Oxford University Press, 1952.) 5s. net.

from applying the obvious rational measures which a situation demands, through the political pressure exerted by sectional groups looking at only one aspect of the situation. That is true of Great Britain and other countries as well as of the United States.

The position is the more dangerous in view of the new situation created by the advent of nuclear weapons. Dr. Conant points out that we are now dealing with the consequences of a new social phenomenon. Until the advent of nuclear weapons, developments in defensive or offensive weapons depended on the special application of the publicly known facts and principles of physics and chemistry. Any new scientific knowledge involved had no revolutionary consequences for the advance of science. The flowering of the whole field of nuclear physics, on the contrary, depended on the expenditure of a large sum of public money, justified in the first instance in terms of the destructive power of a weapon required in a desperate global struggle. Inevitably nuclear physics, thus born of a war-time necessity, was marked from its birth with the secrecy which was anathema to nineteenth-century men of science.

The advance of one whole area of science was thus equated with national security; and Dr. Conant insists that the assumption that science knows no frontier is automatically cancelled and we must face the consequences. We must distinguish sharply between the special position of nuclear science and that of the other fields of physics and chemistry. This is the first step towards preventing the spread of undue secrecy and thereby assisting the progress of science and promoting the welfare of the international community of science.

It is but fair to point out that Government policy in Britain, and probably in the United States also, has on the whole sought to recognize this distinction, however imperfect administration of the policy at times may have been. Another factor to which Dr. Conant directs attention has at times been an embarrassment—the extent to which success in nuclear physics has become a matter of national and political pride. That alone could well account for some of the cruder manifestations of the spirit which has found expression, for example, in the Committee on Un-American Activities or even in some of the investigations under the Loyalty Programme of the United States Government. Dr. Conant does not attempt to justify hysteria, but he appeals for an attempt to understand it; and his lecture gives a welcome reminder that in the universities and elsewhere there has been a much firmer stand against infringements of academic and personal freedom in the United States than could often be gathered from the press.

In this situation Dr. Conant believes that it is impossible to-day, or at any time in the foreseeable future, to have a frank, rational, searching discussion of the industrial uses of nuclear energy. There is no point now in discussing whether the decisions on security regulations in the early days were wise or unwise; but Dr. Conant's own opinion is that misunderstandings and bad feelings between the governments of Canada, Great Britain and the United States might have been avoided by greater frankness at the outset. He thought in 1943, and still thinks, that a treaty should have been drawn up between the three nations dealing with everything even distantly related to nuclear energy.

The chief suggestion he now makes is that an attempt should be made to strike the balance between the demands of security and the demands of justice by a joint commission of the United States and of Great Britain. Such a commission might have to sit behind heavily barred doors; but there is something to be said for Dr. Conant's view that not only is a wise solution more likely to be reached in this way, but also that the way would be prepared for a real partnership in this technical area, comparable with that represented in military matters by the Combined Chiefs of Staff during the Second World War. Even if such a Commission failed to surmount the difficulty in regard to the free exchange of information on nuclear energy noted at the outset, it could scarcely fail to facilitate understanding and co-operation. As Dr. Conant rightly says, the important issue is the future conduct of scientific men, of academic men and of government officials. The more the framework within which these men operate in one country approximates to the framework in which they work in the other, the smoother will be the path of co-operation; and the more nearly that framework is determined on principles which respect the professional loyalties and ideals in which these men are trained, irrespective of nationality, the greater the likelihood of such frameworks being similar. It may not be possible even so to eliminate secrecy or government monopoly; but it should be possible to ensure that they are limited to the minimum consistent with security, and that the area in which the scientific man can work with honest reporting, full discussion, no political interference and full liberty of investigation is as wide as possible.

In this lecture Dr. Conant dealt primarily with the question of Anglo-American relations and co-operation in relation to this problem of securing a sane balance between freedom and security. It is plain enough that he is aware that co-operation and understanding are also demanded not only across such national frontiers and within the ranks of scientific men themselves, but also between different professional groups—between the scientific man and the administrator, whether Civil servant or academic, and between those again and the military authorities and statesmen or politicians. With this aspect, indeed, Dr. Conant dealt at some length in a subsequent speech at a luncheon given in his honour in London by the Pilgrims.

The first barrier to be broken down is that between the scientific men of the free nations, and especially between those of Canada, Great Britain and the United States. The grand academic alliance to promote greater understanding between scholars and administrators in the universities of the United States and English-speaking countries of the Commonwealth which he suggested to the Pilgrims could contribute powerfully to that end, as well as place a further massive stone in the foundations of good Anglo-

American relations. Scientific men to-day depend very largely on administrative understanding for their freedom of communication and contact with their fellows in other lands. It is a matter of governmental or departmental regulation and constraint, and not always financial restriction, that has frequently prevented the free exchange either of information or of visits, and it is well that a man of Dr. Conant's standing should direct attention to the importance of much freer movement of individuals between North America and Great Britain.

Neither country has been free from examples of illiberal restraint on the movement of individual scientific workers, and this plea for closer co-operation between the administrator and scholar on both sides of the Atlantic has already received a warm welcome. It is already known that a strong American delegation is to be invited to the Congress of Universities of the Commonwealth next year in Cambridge; but the effective discussion of Dr. Conant's proposal there will involve much detailed preparatory work, and the careful consideration of administrative as well as financial obstacles to movement. Recent untoward incidents like those in which Dr. L. Pauling and Prof. Lattimore have been concerned may serve a useful purpose in this connexion by indicating some of the errors to be avoided.

In this connexion it should be noted that Dr. Pauling has now been given a passport to enable him to visit Great Britain and France, and that the Council of the American Association for the Advancement of Science has already expressed its concern over the manner in which measures like the McCarran Act are being administered to prohibit American citizens from going abroad, and citizens of other nations from visiting the United States to interchange knowledge of science which does not affect secrecy. At its meeting in Philadelphia last December, the Council strongly urged a review and modification of the administrative procedures under the McCarran Act so as to modify injustices and the damage to American prestige. It has recently been announced that, because of the delays and embarrassments which foreign men of science experience in attempting to obtain even temporary admission to the United States, the International Congress of Psychology, which was to have been held in New York in 1954, will now be held in Montreal, Canada, where procedures for granting visas appear to be more flexible and realistic. In making this announcement, the American Psychological Association expressed its support of the resolution of the American Association for the Advancement of Science; the executive secretary of the Association has said that the real objection of scientific men to the McCarran law is that it uses an axe in dealing with a problem that needs a razor-sharp approach.

Meanwhile, Dr. Conant's speech has encouraged all those concerned with educational exchange between the United States and Great Britain, to the value of which the reports of at least two of the 'productivity teams' have recently testified. The Director of Extra-Mural Studies at the University of Birmingham estimates that whereas some 1,500 students from the United States have attended summer schools in Britain during recent years, it is doubtful whether as many as a dozen British students have been able to get to comparable schools in the United States in the same period. For this disproportion the dollar exchange position is largely responsible; but the security regulations of the United States and the visa hurdles which Dr. Conant condemned have also been major obstacles, and there are other minor ones in the questionnaires which applicants for travel grants under the Fulbright Fund are required to complete.

Informal discussion and keen thinking on the part of scientific men as well as of scholars generally and university and Civil service administrators could do much to assist the formulation of practical proposals which the approval of such a congress as that to be held at Cambridge next year would go far to promoting adoption by both governments and universities. It is essential that such discussion and inquiry should proceed with all vigour, even if it may not be necessary to set up a special commission to deal with the whole subject. The Atomic Scientists' Associations in Great Britain and in the United States could well help in this matter, and already the Present Question Conference at Oxford last August* on "Freedom and Responsibility" has assisted in bringing out some of the issues underlying co-operation in this field, while the forthcoming conference on "Conflicts of Loyalties" should further clarify thought.

What has to be realized is that such a matter as the academic alliance which Dr. Conant suggests is not a matter for the universities alone, quite apart from the way in which implementation of any such project may depend upon government action to remove restrictions on movement or even upon government financial support. It is linked up with what is possibly an even more fundamental issue, namely, that of facilitating effective public discussion. Dr. Conant himself referred to the dangerous consequences of the present position, which virtually deprives the public of the accurate and authentic information without which a sound judgment of public policy in this field is impossible, and this is the issue to which, above all, immediate attention is imperative.

Unless that problem is handled wisely, public support is unlikely to be forthcoming for any measures of Anglo-American co-operation in the academic field, still less for any modification of the relations between atomic scientists and the State. Re-examination of institutions and organizations in Britain is imperative even if, as Sir John Cockcroft said at the Present Question Conference, for the moment a working solution has been found which preserves a reasonable degree of freedom for scientific work in nuclear physics. These arrangements need, however, to be scrutinized in a wide context and against the background of the ideas and principles on which a democratic society is based.

* Question: a Journal. Edited by H. Westmann. Vol. 4, No. 2: Freedom and Responsibility? By Prof. H. D. Lewis, H. J. Blackham, Dr. J. Bronowski and Wells Coates. (Published for the Present Question Conference, Ltd.) Pp. 105–216. (London: Hammond, Hammond and Co., Ltd., 1952.) 2s. 6d.

Dr. J. Bronowski's address to the Seventh Present Question Conference brought out very clearly both the dangers of the present situation and the implications for the scientific man. Vindicating, like Sir John Cockcroft before him, the scientist from the charge of irresponsibility in his scientific work, Dr. Bronowski insists that the great responsibility of the scientific man to-day is to become a teacher to the whole community, and to help his fellow men to understand clearly the implications of the forces which science has released and the changes science is bringing about. Only so is there any hope of society acquiring the wisdom which is required for it to regain control over events, and to choose those directions which tend to good and turn from those that do not. Dr. Conant's addresses should inspire an even wider circle of scientific men and other scholars to turn to the imaginative and constructive thinking out of which will emerge the new institutions of Anglo-American co-operation, whether in science, in the universities or in world affairs generally.

ENTOMOLOGY AND CITRUS FRUIT PRODUCTION

Citrus Entomology in the Middle East

With Special References to Egypt, Iran, Irak, Palestine, Syria, Turkey. By F. S. Bodenheimer. Pp. xii+663. ('s-Gravenhage : Dr. W. Junk, 1951.) n.p.

PROF. F. S. BODENHEIMER'S work is a very thorough compilation of almost all that has been published in the literature, since it covers all the living organisms of the animal kingdom which are related to the now almost universally important problem of citrus fruit production. The part played by insects being by far the most predominant, the author gives an exhaustive account of the results of investigations on the insect pests in the countries surrounding the eastern Mediterranean. In chapters on flies (Diptera), scale insects and thrips, Prof. Bodenheimer fully discusses the ecology of each major pest, selecting not only good and concise descriptions of the species but using also the most recently adopted nomenclature—with keys for the identification of the major groups, as well as of the species. The geographical distribution, a list of the host plants, the seasonal history, the correlation of the development of the insect to temperature and humidity (illustrated by ecoclimograms), threshold of development, thermal constant and the number of generations are given for every important species. Reproduction and productivity, differences between summer and winter eggs, sexual fluctuations, biology of nutrition, fluctuation of populations as a result of change in the nutritional properties of the soil, and numerous other details are discussed and illustrated by a large number of useful tables and graphs. The natural enemies, parasites and predators are studied and supported by judicious conclusions as regards their varying importance based on their biology.

It is to be regretted that Prof. Bodenheimer's book has been considerably retarded owing to the Second World War, for during the past few years the measures of control, particularly those dealing with the most disastrous species of scale insects, have undergone many improvements.

It is unfortunate and regrettable, also, that the list of the most important literature at the end of each chapter does not extend beyond 1946, when the text (Prof. Bodenheimer in his introduction admits that the manuscript of the book was sent to Amsterdam during the early part of the War) is said to have been entirely revised. Moreover, earlier papers such as the valuable piece of research by Dr. A. D. Hanna, on *Ceratitis capitata* Wied. (*Bull. Soc. Fouad I d'Entom.*, **22** (1938), **31** (1947) and **32** (1948)), are not mentioned in the bibliography. The completion of the work in this respect would have considerably enhanced the value of the book. In my opinion, it would have been preferable to combine the bibliography of each chapter at the end of the volume, and an alphabetical index of the names of insects dealt with should have been added.

In spite of these remarks, Prof. Bodenheimer's "Citrus Entomology" is an authoritative and indispensable book, being written with a breadth of view only to be acquired by a truly scientific outlook. I recommend it not only to agricultural research institutes and citrus farmers but also to entomologists the world over.

H. C. Efflatoun

PARASITES AND PARASITISM

Parasitic Animals

By Dr. Geoffrey Lapage. (Cambridge Library of Modern Science.) Pp. xxi+351+8 plates. (Cambridge : At the University Press, 1951.) 21*s.* net.

THIS is not intended to be a text-book of parasitology, but it does contain a considerable amount of factual information concerning a number of forms, mostly those affecting man or domesticated animals. It could only have been written by one who had, like Dr. G. Lapage, devoted years to the study of parasites and parasitism with its manifold practical and theoretical implications. It may be regarded as almost an ecological study of highly specialized animals living in remarkable environments and a discussion of the general principles underlying the relationship. The author makes a plea, that in considering the many aspects of the subject, the student should try to overcome the prejudice resulting from a knowledge of the diseases, pain and loss caused by parasites and should turn to the beauty of the remarkable adaptations they illustrate.

From the method of approach, the arrangement of the contents can be neither that of systematic zoology nor of medical practice. Dr. Lapage has, with success and as the result of the exercise of much thought and ingenuity, produced a logical sequence in the method of presentation. The methods of contact between parasite and host and the ways in which the parasite reaches its resting place are arranged and discussed in a series of examples of increasing complexity. Similarly, the descriptions of life-histories of parasites are not only divided into chapters according to whether one or more than one host is involved, but also within each chapter the life-histories are arranged in series beginning with the most simple and passing by steps to the more and more complex. With this factual material for reference, the author considers the effect of the parasitic mode of life, first upon the parasite itself and secondly upon the host. This naturally leads on to more general questions such as tissue reactions and immunity, and other aspects of the host–parasite

relationship. There are but few slips in the book; but some readers will doubtless consider that the discussion starting on p. 14 as to whether the fœtus of the mammal is to be regarded as a parasite involves stretching the meaning of the word parasite beyond legitimate biological limits. Indeed, it runs against the grouping of animal associations set out on p. 2, where parasites are placed in associations of animals belonging to "different zoological species".

This, however, is a minor point in a most interesting, readable and very useful book. It will appeal to specialists and general zoologists alike, and certainly should be read by all students whose courses include a consideration of animal parasitism. Even the lay reader will be able to follow its clear style without too much difficulty and find in it much that is of interest and thought-provoking.

ELECTRICAL BREAKDOWN OF SOLIDS

Dielectric Breakdown of Solids

By S. Whitehead. (Monographs on the Physics and Chemistry of Materials.) Pp. xv+272+18 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 25*s*. net.

ONE may often read of the need for greater interest, in Britain, in the applied sciences and for a more widespread appreciation of their value in education and in industry. Indeed, it is sometimes almost possible to detect, even in authoritative articles, the reiterated outline of a standard complaint. There is, however, little doubt that more attention should be paid, primarily in universities, to applied physics, for example, and the well-known Oxford series of "Monographs on the Physics and Chemistry of Materials" is contributing notably to that end.

The present book, by Dr. S. Whitehead, director of research of the Electrical Research Association, is one of the latest additions to the aforementioned series, and covers as fully as possible in 272 pages the important subject of electrical breakdown in solids. This is apparently the only modern book of its kind and follows an earlier one written by the same author some twenty years ago.

The purpose of the book is to review recent fundamental work in a form suitable for physicists working in university, government or industrial laboratories. It will probably be little used at the present time by undergraduate students in most universities; but research students and graduates in general, working on the solid state, will find it of great value.

The author is an outstanding authority on his subject and, with his colleagues in the Electrical Research Association, has been responsible for many advances, especially in the study of the effects of small voids in solid insulation. It is therefore not surprising to find in the book a masterly, but necessarily condensed, treatment of the subject. The chapters deal with intrinsic breakdown, including a full treatment of the theory of breakdown in simple crystals, which is one of the most fundamental parts of the book; thermal breakdown; breakdown caused by discharges, external or internal to the solid dielectric; electrochemical deterioration; and, finally, dielectric breakdown in technical practice. It is, perhaps, surprising that more space was not devoted to surface sparkover, in view of its great technical importance, even though this is not strictly a problem in breakdown of solids and is controlled greatly by the nature of the electrodes, which diminishes its attraction as a basic general problem. The description of the effects of internal discharges in dielectrics is particularly comprehensive. It seems unfortunate that, having achieved the impossible once, Dr. Whitehead should not have achieved it again by including even one or two chapters on breakdown in liquids.

The book has exceptional value in many respects, but perhaps especially in directing attention repeatedly to the lack of experimental data obtained in controlled and simplified conditions. This applies even to the relatively simple case of electrical breakdown in ionic crystals, and to the study of thin films, where the work of a very few investigators stands out. It is remarkable, as Dr. Whitehead's book so clearly shows, that such an important subject as the electrical breakdown of solids has attracted, with a few notable exceptions, such a small number of research workers. This excellent work should do much to stimulate others.

STATISTICS AND THE CHEMIST

Statistical Methods for Chemists

By W. J. Youden. (Wiley Publications in Statistics.) Pp. x+126. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 24*s*. net.

IN this short book, chemists are shown not only how to use statistical analysis but also why to use it and how to plan investigations so that numerical observations will be made to the best advantage. Dr. W. J. Youden writes as one of the few chemists who have studied and practised modern techniques of statistics: his book is full of the wisdom that comes from long experience of his subject-matter.

The book is elementary and well suited for a reader without previous knowledge of statistics. Theory and proofs are almost entirely absent, yet the logical basis of the methods discussed is always clear. The first chapter displays the need for proper statistical treatment of chemical data by showing—a favourite theme of mine—that often the man who refuses to use statistics is in reality using inefficient statistical methods when better ones are readily available. Subsequent chapters relate to the various concepts that enter into analysis of variance, regression analysis, and experimental design, together with short sections on sampling. In the main, the presentation is of the kind familiar in texts of biological statistics; but it takes on a distinctive character because the illustrations are drawn from chemical investigations. Dr. Youden rightly insists that a proper understanding of the functions of statistics in chemistry can be attained only by study of practical problems; he therefore puts before his readers a fine and varied selection of experimental data, largely from pieces of research with which he has been personally concerned. Especially valuable are the explanations of experimental designs and their uses. Dr. Youden gives an excellent introduction to incomplete blocks and complete and incomplete replications of factorial schemes; but the emphasis is on general principles rather than details of interpretation, and the chemist concerned with elaborate experiments would probably need further guidance from another book.

Perhaps the most surprising point is the complete absence of any discussion of discrete variation: neither χ^2 nor the binomial distribution is mentioned. The discussion of sampling is rather inadequate, and no mention is made of quality control, a branch of applied statistics that would seem to be of special interest to chemists. The very brief chapter on regression would be improved by some recognition of the existence of multiple regression methods. Such flaws are inevitable in so short a book, but a study of what Dr. Youden has said should encourage many chemists not only to put his simpler procedures to immediate use but also to read more widely in other text-books of applied statistics. D. J. Finney

SURVEY OF CANCER IN LONDON DURING 1938-39

British Empire Cancer Campaign

A Survey of Cancer in London: Report of the Clinical Cancer Research Committee. By Dr. W. L. Harnett. Pp. vi+834. (London: British Empire Cancer Campaign, 1952.) 45*s*.

BETWEEN 1936 and 1938 the Clinical Cancer Research Committee of the British Empire Cancer Campaign designed thirty-one detailed case-sheets, applicable to patients suffering from cancer in the various regions of the body, which were distributed to all the voluntary and London County Council hospitals and most of the special hospitals in the County of London. 15,200 patients were registered from April 1938 to September 1939, and the data on their case-sheets coded by Colonel W. L. Harnett, the full-time medical secretary and registrar to the Committee. A five-year follow-up was carried out, and only four hundred cases could not be traced. The primary design was to secure accurate information on the efficacy of the various methods of treatment available; but, in addition, much data on other aspects of clinical cancer were obtained. Analyses on half the material were published in the Annual Reports of the British Empire Cancer Campaign. This survey gives the revised findings, both summarized and detailed, in the whole series of patients.

There were sufficient cases for detailed analyses in thirty-four out of the forty-three sites of registered malignancy. Each site is analysed under about thirty headings, which, in addition to types of therapy and follow-up, include age distribution, occupation and social class, relevant past history, first symptoms, delay in treatment, findings on examination, clinical stages, actuarial estimation of survival after treatment, biopsy reports and causes of death. The number of cases in the commoner cancers is large—breast, 2,152; stomach, 1,405; rectum, 1,390; skin, 1,080; lung, 1,024; colon, 892; cervix uteri, 859; bladder, 423; pharynx, 385; prostate, 383—and their analyses are thereby of great significance.

Comparison of different treatments summarized from the whole data favours radical surgery combined with radiotherapy over radical surgery, while the latter was better than radiotherapy alone. However, the results varied according to the site, stage, age and selection of the patients. In cancer of the breast, for example, post-radical mastectomy irradiation slightly improved the long-term results in clinical stage III*b* but not in any other stage. Again and again throughout the survey, the already long-established fact is accentuated by the tables that early cases of cancer do well with any orthodox treatment but that, once the lymph nodes are involved, the number of five-year survivors is considerably reduced, whatever the treatment. The totals of all sites variously treated, analysed according to stages, showed a five-year survival-rate of 38·7 per cent in stage I, 20·0 in stage II, 13·2 in stage III and 1·5 in stage IV. About one-third of all cases proved to be clinical stage I on admission to hospital.

The interval from first symptom to medical consultation varied greatly with the site. It was less than three months in 53·1 per cent of the 12,277 records in which the data were available, and more than six months in 20·8 per cent. Of the 12,125 patients who consulted a medical practitioner, 68 per cent were referred to hospital at once. The five-year survival-rate for all methods of treatment was 19·22 per cent of the 14,182 patients with primary cancer. In his introduction to the "Survey", Sir Heneage Ogilvie says that this figure would have been raised to 38·7 per cent had all patients come to hospital while the disease was still in stage I. This is an indirect plea for earlier diagnosis and treatment, laudable but perhaps over-optimistic with regard to the benefit which might ensue, since rapidly growing and spreading tumours constitute a fair proportion of most groups of malignancies. It is a pity that the Research Committee did not look into this matter by an attempt to correlate the stage with the length of history. Such a correlation might establish how many advanced cancers are in that state because of prolonged delay in diagnosis and how many are due to the presence of a rapidly spreading tumour. In a number of sites the survival-rate has been correlated with duration of symptoms and, interestingly enough, rarely shows any statistically significant difference between patients who came under treatment within the first six months and those who delayed longer.

Analyses of social class agree with the Registrar-General's conclusions from mortality figures that the poorer groups are more liable to cancer of the tonsil, pharynx, lip, mouth, tongue, œsophagus and skin. The significance of the findings in the patients' relevant past history, such as incidence of unsatisfactory dental conditions, heavy smoking or excessive alcohol consumption in relation to cancer of the mouth, pharynx and larynx; pre-existing goitre with cancer of the thyroid; gall stones with cancer of the gall bladder and a number of other conditions cannot be judged because of the absence of data on their incidence in a control non-cancerous population selected at the same time. A previous history of tuberculosis, pneumonia and influenza was recorded in the cancer of lung series; it was unfortunate that smoking habits were not recorded in these patients.

This survey is an example of a research approach which is likely to prove every whit as important as the laboratory one, and which, if the right questions are asked, might be even more fruitful. As it stands, we see the state of cancer at the hospitals of Greater London in the year preceding the outbreak of the Second World War, preserved for posterity—a baseline for studies on changing incidence, diagnosis, clinical manifestations and treatment. Everyone interested in malignant disease will be deeply indebted to the British Empire Cancer Campaign for its production of this unique and monumental survey of cancer in London. I. Doniach

THE OAK RIDGE 86-INCH CYCLOTRON

By Dr. ROBERT S. LIVINGSTON
Oak Ridge National Laboratory, Tennessee

THE construction of an 86-in. high-current proton cyclotron of the fixed-frequency type was started at Oak Ridge in August 1949. Design and fabrication of the machine was completed by the staff of the Oak Ridge National Laboratory with the assistance of other personnel and facilities of the Carbide and Carbon Chemicals Co. in almost exactly one year. On November 11, 1950, the first beam was obtained. The cyclotron now produces an internal beam in excess of one milliampere of protons at 24 MeV. At this energy the relativistic increase in mass is 2·6 per cent.

The maximum particle energy which a fixed-frequency cyclotron can produce is a function, of course, of the available dee voltage. When proper account is taken of the rate and shape of magnetic field fall-off, ion 'phase grouping', relativistic mass increase, and electric and magnetic focusing, the threshold voltage for any given energy can be calculated reliably[1].

The major specifications of the 86-in. cyclotron are as follows: diameter of pole face, 86 in.; maximum beam radius, 33 in; magnetic field strength, 9,000 oersteds; resonance frequency, 13·4 megacycles per sec.; peak dee-to-dee potential, 300 kV. min., 500 kV. max.; dee-to-dee gap, 4 in.; dee width, 8 in.

The cyclotron is unique in that the orientation of the magnetic field is at right angles to that in conventional machines (Fig. 1). The dees are suspended vertically and can be lowered into the vacuum tank by a crane. The magnet, vacuum system, oscillator and testing console are in a room 28 ft. × 34 ft. This room is entirely surrounded by a shielding wall of ordinary concrete 5 ft. thick. Three walls are solid and the fourth is of blocks laid without mortar. The overhead portion of the shielding is composed of removable blocks which provide convenient access when modifications are required. An operating console, 400 ft. away from the cyclotron, provides for additional protection from radiation while the machine is operating at high level.

The U-shaped magnet yoke for the cyclotron is 40 in. × 62 in. in cross-section and weighs 250 tons. The vacuum system consists of three 20-in. oil-diffusion pumps, each equipped with an 8-in. booster pump, exhausting to a common header and backed by a 15-h.p. mechanical pump. The total pumping speed of the system is 15,000 litres per sec. at 0·03 micron.

The oscillator is of the grounded-grid self-excited type using a single Federal 134 tube. This tube is rated at 400-kW. input and 150-kW. plate dissipation. Several systems were investigated for overcoming the well-known 'ion loading' phenomenon, which makes it very difficult to obtain satisfactory starting conditions with the self-excited oscillator.

A dee-bias system using a negative 1,000-V. potential on the dees is the most successful method tried for control of ion loading. In investigation of other methods, the use of a pre-exciter oscillator was tested, and a charged-grid system made of copper tubes was suspended between the dees and the ground plane. It was found that the biasing system produces

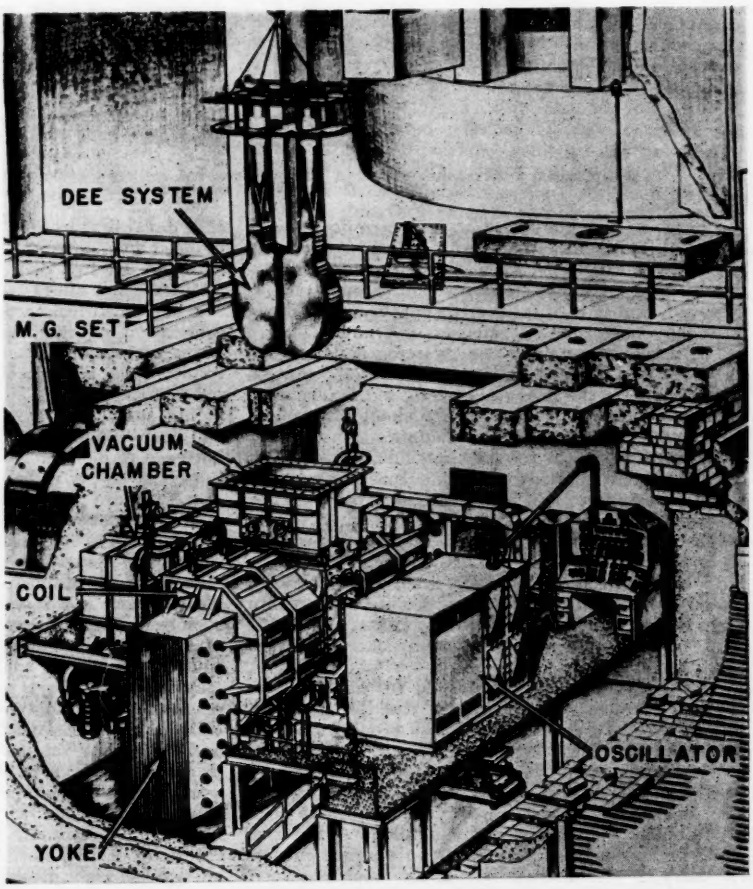

Fig. 1. Artist's sketch of the 86-in. cyclotron installation showing motor-generator, vacuum system, magnet, dee assembly, oscillator cabinet, and shielding

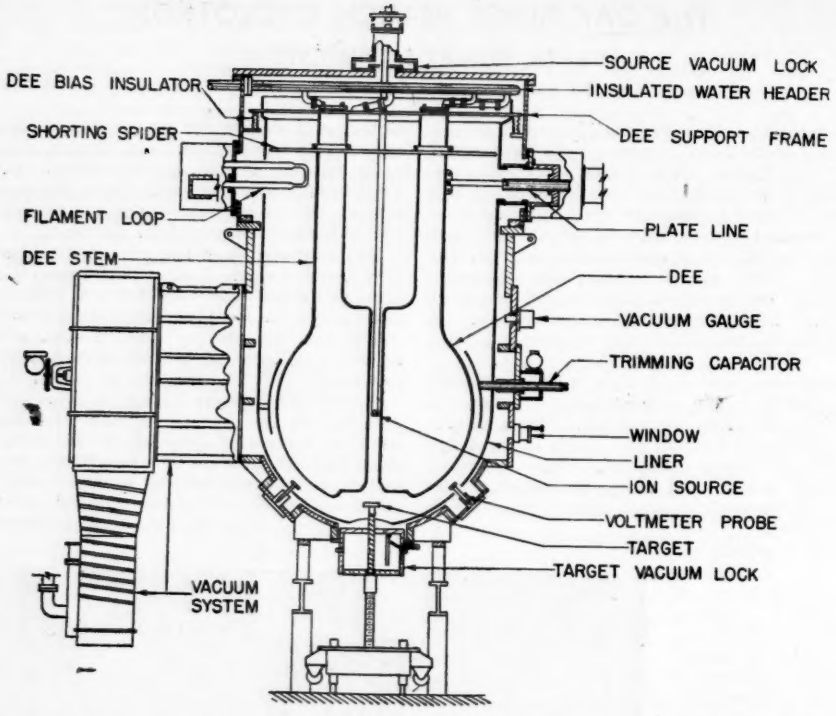

Fig. 2. Diagram of the resonant dee system. The ion source and the target are inserted through vacuum locks, from above and below respectively

the most dependable operation and permits a much higher dee voltage than the grid system. At present the voltage ranges between 280 kV. and 400 kV. dee to dee. Highly stable oscillator operation is achieved, and it is of interest to note that the oscillator may be turned on safely at full power.

The resonant system of the cyclotron is illustrated in Fig. 2. The copper-plated stainless steel framework which supports the dees rests upon, and is insulated by, four stand-off type cylinders of Alsimag 222 (American Lava Co.). A 500 $\mu\mu$F. capacitance is inserted in series with the plate transmission line, at the tube end, to prevent shorting of the D.C. bias. It was not found necessary to add any condensers between the 'r.f.-shorting-spider' and the liner; but great care is taken to balance the capacity of the dees exactly in order to minimize the 'unbalanced' current which flows between the dees and the liner. Heavy silver-plated copper clamps, with water cooling, successfully carry the very large radio-frequency currents ($\sim$ 5,000 amp.) at the voltage node of the resonant quarter-wave dee system.

In this cyclotron it was desired to use large circulating currents without making the dees intensely radioactive. To accomplish this, the dees are completely lined with a layer of graphite, so that any stray protons are prevented from impinging directly on the copper. The leading edges of the dees are also of graphite. It was gratifying to observe that after one million μampere-hours of operation, the dees could be approached quite safely within a few hours for carrying out alterations. It has been observed that the limiting activities near the cyclotron, exclusive of the targets, are those due to silver-110 (270 days) and iron-59 (43 days), both of which are induced by neutrons. In the fabrication of future dees, an attempt will be made to eliminate silver (from brazing alloys) completely.

A simplified technique has been worked out for the fabrication of components of the resonant radio-frequency system, where large amounts of heat due to either the radio-frequency heating or to impingement of the beam must be removed. This has proved highly satisfactory for such structures as the dees and liner. Water tubes of 0·875-in. outside diameter, flattened to increase the area of contact, are furnace-brazed to sheets of copper 0·090–0·125 in. in thickness. 'Heliarc' welding is used in joining sheets where high conductivity is desired, and vacuum-tight construction is not required. Continuous lengths of tubing are used wherever feasible.

In order to establish the energy of the beam by a measurement not dependent on the geometry of the cyclotron, three different methods have been used. The first of these consists of the bombardment of stacks of thin foils such that the depth of activity may be traced for a particular reaction. The best results by this method have been obtained with copper foils. The reactions used were $^{63}Cu(p,n)^{63}Zn$ and $^{63}Cu(p,2n)^{62}Zn$, having extrapolated activation thresholds of 4·5 and 14·5 MeV., respectively. Some work has also been done with carbon foils by tracing the activation as a function of depth for the $^{12}C(p,pn)^{11}C$ reaction, which has an extrapolated threshold of 18·7 MeV. In the second method, the energy has been measured by allowing the beam to impinge upon a photographic plate after passing through a stepped aluminium absorber. The third

method is by the use of a 'burn-out target' consisting of a series of separated lead foils placed across the path of the beam. The curvature of the 'burn-out' pattern produced by the circulating beam and the known intensity of the magnetic field give a maximum value of the energy.

These methods of measurement are all in substantial agreement and indicate that the energy of the beam can be as much as perhaps 10 per cent higher or lower than that calculated from the cyclotron geometry. The variations in energy are dependent primarily on the position of the ion source.

A particular problem with this cyclotron is the design of internal targets and the facilities for installing and removing these targets from the cyclotron. The target-mounting assembly is permanently arranged on a stainless steel carriage. Hydraulic cylinders are incorporated in the carriage for actuating the target dolly by remote control and for holding the target face-plate against the vacuum lock. The carriage contains a separate motor-driven screw mechanism for raising or lowering the target to the desired radius. For rotating targets, provision has also been made for an auxiliary motor drive.

While many types of targets have been designed, two are described to illustrate the types of arrangements which have proved practical. In the first type, the beam passes through a 0·015-in. aluminium window and into the target directly behind the window. Cooling water circulates in contact with the target, which is held in place by a spring clip. This is a convenient system for irradiating metallic targets when only a few microampere-hours are needed. Beams greater than 100 μamp. have been used without damage to the aluminium windows.

When larger irradiations are desired, it has been found convenient to place a target at a small angle to the incident beam (2–5°) and to make the target as large as possible. Aluminium targets 6 in. × 10 in. have safely withstood more than 30 kW. of beam, measured calorimetrically. It should be noted that it is necessary to have high-velocity water flowing in the cooling circuit in such a target in order to obtain sufficient heat transfer. The induced activities at large beam currents are extremely high. A zinc target bombarded for an hour at 400 μamp. gives 50 R./hr. at 1 m. On a beryllium target, one neutron is released for approximately every fifty incident protons. To facilitate quick and easy removal of such 'hot' targets, an arrangement has been designed such that a quarter turn of a lever permits removal of the target with a pair of long tongs or with remotely operated handling equipment.

[1] Cohen, B. L., "Fixed Frequency Cyclotron Theory", April 4, 1951, *AECD*-3301.

VARIABLE STARS AND GALACTIC STRUCTURE*

By CECILIA PAYNE-GAPOSCHKIN

THE intrinsic variable stars are the stars whose changes of brightness, temperature and spectrum are the results of physical changes of a single object, in contrast to the geometrical variables, which show the effects of periodic eclipses of a close stellar pair. Intrinsic variables may be roughly divided between the pulsating variables (which undergo periodic or quasi-periodic changes governed by their physical properties) and explosive variables (which undergo changes that are more nearly explosions, and are, at the most, cyclic in nature).

Variable Stars

The pulsating variables embrace the classical Cepheids (periods of a day to fifty days or more); the *RR* Lyræ stars (periods less than a day); the yellow semi-regular variables (including the *W* Virginis stars, the *RV* Tauri stars, and the stars such as *SX* Herculis, with periods that range from about twenty to more than a hundred days), and the long-period variables with large ranges, and periods from rather less than a hundred to almost a thousand days. These divisions are not arbitrary, but are borne out by the physical nature of the stars in each group, as well as by their distribution and motion. Although all seem to undergo some type of pulsation, little progress has been made in understanding the details, or in analysing the complex interrelationships that exist between brightness, temperature, spectrum and radial motion of the surface.

The explosive variables include the supernovæ, the classical novæ, recurrent novæ, and dwarf novæ (*U* Geminorum and *Z* Camelopardalis stars). They are listed in descending order of maximal brightness; with the exception of the supernovæ, their outbursts are probably cyclic, those that reach the smallest luminosity at maximum having the shortest cycles. For these stars also, the abrupt changes of brightness, and the associated complex changes of spectrum, temperature and surface velocity are at present understood only in the most general way.

The intrinsic variables, despite the difficult physical problems that they present, can be studied fruitfully from another point of view. All are stars above the average in luminosity, and for each class the absolute magnitudes are fairly well determined. Therefore they can be located within the galaxy when correct allowance has been made for obscuration (a problem at present only approximately soluble), and the structure of the galactic system can be studied by their means better than in any other way.

Galactic Structure

The distribution of any group of stars within a galaxy may be regarded as the instantaneous result of the motions of the stars concerned. We shall find that the intrinsic variables fall into definite groups, not only on the basis of physical behaviour and of distribution, but also of motion. They form part of the general picture of the complex structure of our galaxy, which we may regard as the outcome of the motion of stars, nebulosity, and dust, in orbits of a variety of sizes, shapes and inclinations about the centre of the system.

A spiral galaxy, such as we may suppose our own system to be, has a complex structure. The main part of the light comes from a somewhat flattened spheroidal mass of stars, which also contains most of the mass. The spiral arms, superficially conspicuous in spirals such as Messier 31 in Andromeda, contribute perhaps ten per cent of the light, and are confined to a comparatively thin central layer, which also contains the dust and gas. This picture, which has emerged from the study of the nearer spiral galaxies, seems to be applicable to our own system, though in the latter the structure is more difficult to

* Synopsis of three lectures given in the University of London on May 5, 7 and 8.

trace; this is because the sun happens to lie at present almost in the central plane, so that we encounter the full obscuring effect of the layer of dust.

Stellar Populations

Within our own galaxy, the motions of the stars give a clue to the structure of which they form part. Stars characteristic of arms move in nearly circular orbits of low inclination; stars of the substratum may move in orbits of high inclination, and also of high eccentricity. Therefore their motion relative to the sun (which shares the motion of stars associated with the arms) may be considerable, and they embrace the 'high-velocity stars', first recognized by Oort. In the notation first suggested by Baade, the stars characteristic of the arms are known as 'population I', those of the substratum as 'population II'. Extreme specimens of population I are the galactic (sometimes called the open) clusters: they are confined to the galactic plane and move in nearly circular orbits. Extreme examples of population II are the globular clusters, which form a nearly spherical system about the galactic centre, and the large dispersion in their radial velocities places them among the high-velocity objects.

The galactic and globular clusters show a profound difference of population. The brightest stars of galactic clusters are the bluest—often blue super-giants of great luminosity—and their members run downwards along the main sequence; such clusters may, however, contain a few red giants. The brightest stars of globular clusters are the reddest, and are never as bright as the brightest blue stars of such galactic clusters as the Double Cluster in Perseus and the Pleiades.

The main population of the globular clusters runs from red to blue towards lower luminosity, and appears (from recent work at Mount Wilson) to converge with the main sequence for stars not much different in brightness from the sun. Globular clusters contain some bluer stars, which tend to form a branch of the colour-luminosity array near absolute magnitude zero; this branch embraces a variety of colours. The *RR* Lyræ stars, which are very numerous in many (though by no means in all) globular clusters, lie on this branch. These two population-patterns are characteristic respectively of stellar populations I and II. It is tempting to see in them a contrast which results from difference of origin, age or history.

Characteristics of Variable Stars

In order to relate the distribution and motion of a group of stars to the structure of our galaxy, we need to know their distances, and therefore their absolute magnitudes. This information is available for five main groups of intrinsic variables.

The *classical Cepheids* are distinguished by concurrent changes of brightness and radial velocity, by the relation between period and minimal spectrum, and by the progression of form of light curve with period (the Hertzsprung relation). They form a distinctive, but probably not a homogeneous, group, for none of the three relations mentioned is unique. The absolute magnitudes tend to be greatest for the Cepheids of longest period (the period-luminosity law, established by Miss Leavitt in the Magellanic Clouds, and assumed to be valid for all classical Cepheids). The Magellanic material establishes the scale of the period-luminosity curve; but the zero point must be established from the motions of comparatively few nearby galactic Cepheids, as has been done by R. E. Wilson. The absolute photographic magnitudes of classical Cepheids, which are thus functions of period, lie between -1, for the shortest periods, to about $-4{\cdot}5$, for the longest. Classical Cepheids include the most luminous of intrinsic variables.

The luminosities of the *long-period variables* must be derived entirely from the motions of galactic members of the group. They are found by Merrill and R. E. Wilson to range from about $+1$ for the longest periods to about -2 for the shortest. The relation is less simple than for the classical Cepheids, since the long-period variables of shortest period tend to be high-velocity stars, and the velocities appear to bridge the gap separating populations II and I between the shortest and the longest periods. Studies of luminosity that are based on proper motions require modification for high-velocity stars, and therefore the luminosities of individual long-period variables cannot be confidently inferred from period alone. These variables cannot, moreover, be shown to consist of two distinct groups, for the gradation of motion (and distribution) is continuous, and there seems to be no relation between motion and such physical properties as can be inferred from spectra. Our knowledge of the distribution and motions of the long-period variables is thus necessarily less definite than for the classical Cepheids.

The *red semi-regular variables*, with very few exceptions, share the motion that is typical of population I; their absolute magnitudes are shown, by the studies of R. H. Wilson, Joy and Keenan, to be in the neighbourhood of 0 or -1, except for the readily recognizable super-giants, such as Antares and *AD* Persei.

The luminosities of the *yellow semi-regular variables*, which include the *W* Virginis stars, the *RV* Tauri stars, and such stars as *SX* Herculis, have been established by Joy's studies of variables in globular clusters; they range from -1 to -3. These stars are distinctive in light curve and in spectrum; in particular, the *W* Virginis stars can be readily distinguished from classical Cepheids of similar period by their striking departure from the Hertzsprung relation.

The *RR Lyræ stars*, distinctive in period and in form of light curve, have been shown by a number of investigators to have an absolute magnitude near zero. They are, moreover, all sensibly of the same luminosity. As they are high-velocity stars, the absolute magnitudes of the galactic members, on which the determination necessarily depends at present, must be evaluated on the basis of radial velocity only.

Distribution of Variable Stars

Although only a fraction of the total of galactic variable stars has been discovered, their apparent distribution, in conjunction with our knowledge of their luminosities, and approximate corrections for obscuration, permits us to draw certain conclusions about true distribution. From the fragmentary material available, it is only legitimate to arrange the distributional parameters in order. *Horizontal gradient* expresses the rate at which stars of a given type increase in numbers along a galactic radius from the centre outward. *Vertical gradient* expresses the rate at which they fall off above and below the galactic plane.

The horizontal gradient is greatest for the *RR* Lyræ stars, and almost as large for the long-period variables of shortest period. For variable stars of other types it is too indefinite to be evaluated. The vertical gradient is smallest for the globular clusters (extreme population II); then follow, in order, the *RR* Lyræ stars, the *W* Virginis stars, the *RV* Tauri stars, the long-period variables of short period, the long-period variables of long period, the semi-regular red stars, the classical Cepheids, and finally the galactic clusters (extreme population I). From this it follows that the globular clusters form the most spherical subsystem of the galaxy, and the succeeding objects constitute more and more flattened subsystems, until we reach the classical Cepheids and galactic clusters, which are practically confined to a thin layer near the galactic plane.

The novæ appear to form a system which is notably concentrated towards the galactic centre, being not so closely confined to the galactic plane as the classical Cepheids, but more flattened than the system of *RR* Lyræ stars. The planetary nebulæ have been shown by Minkowski to be concentrated in the direction of the galactic centre, but, until their distances are measured, neither the horizontal nor the vertical gradient can be evaluated. Their distribution suggests that of the novæ.

Motions of Variable Stars

The motions of the various types of intrinsic variables are even less completely known than the distributions. The Bottlinger diagram (despite its crude implication of Keplerian motion, and the severe limitations imposed by selection) provides a method of arranging the motions in definite order. When the observed motions of variable stars are inserted in a Bottlinger diagram, one can determine the distributions of eccentricity and semi-major axis of the instantaneous orbits. In order of decreasing median eccentricity, we find the *RR* Lyræ stars, the long-period variables of short period, the red semi-regular variables, the long-period variables of long period, and finally the Cepheids with essentially circular orbits. The median semi-major axes do not differ sensibly except for the *RR* Lyræ stars, which have the smallest.

If we accept the crude assumption of Keplerian motion (probably approximately valid in our own sparsely populated neighbourhood), we can calculate the average perigalactic distances for the stars of various types: the smallest are those of the *RR* Lyræ stars, followed in order by the long-period variables of short period, the red semi-regular variables, the long-period variables of long period, and the classical Cepheids. Unfortunately, our knowledge of the motions of the yellow semi-regular variables is at present too scanty for application here; they do, however, contain a considerable proportion of high-velocity stars (as shown by Joy's study of radial velocities), and would probably fall between the *RR* Lyræ stars and the long-period variables of short period.

Galactic Structure and Variable Stars

The distribution of variable stars shows a continuous graduation from the nearly spherical subsystem of the *RR* Lyræ stars (which approaches that of the globular clusters in form, if not in extent) to the highly flattened system of the classical Cepheids (which approaches that of the galactic clusters). The galactic clusters themselves contain a considerable proportion of the highly luminous hot stars, the more so if we include in our conception the looser associations of hot stars which have long been known to be concentrated in the galactic plane. Variable stars, then, strengthen the conception of a galaxy built of a number of concentric subsystems, flattened to various extents.

When we seek among the variable stars for evidences of structure within the central layer of the galaxy, which contains dust, gas and high-luminosity hot stars, we are on less sure ground. Recent studies by W. W. Morgan have suggested the feasibility of tracing actual spiral structure within the central layer by means of the bright nebulosities excited by high-temperature stars. If any intrinsic variables share the spiral structure, we should expect the classical Cepheids to do so. The distribution of these stars in the galactic plane does, indeed, seem to suggest a concentration parallel to the spiral structure suggested by the bright nebulosity, but the features are extremely broad and indefinite.

Even if we allow for the possible dispersion about the period-luminosity curve that seems to follow from the Magellanic material, it is difficult to believe that the galactic Cepheids are confined to narrow, arm-like regions. Rather they seem to be spread into a sheet, which perhaps shows a tendency to concentration in spiral lanes. The few Cepheids that were found by Hubble in Messier 31 seem also to be broadly scattered, rather than to be concentrated in narrow, arm-like regions such as Baade has recently photographed by means of the bright nebulosities. The classical Cepheids, therefore, while definitely affiliated with population I, are not such extreme members of it as the high-luminosity hot stars which are the brightest members of many galactic clusters.

NEWS and VIEWS

National Chemical Laboratory of India: Prof. G. I. Finch, M.B.E., F.R.S.

Prof. G. I. Finch has been appointed by the Council of Scientific and Industrial Research, India, as director of the National Chemical Laboratory of India, Poona, in succession to Prof. J. W. McBain, who has recently retired. Prof. Finch has had a long and distinguished academic career. After studying physiology under Charles Richet in Paris, he went to Zurich to read chemistry and physics under Treadwell, Willstätter, Bredig, Lunge, Berl, Weiss and Einstein. On graduating, he served as assistant to Bredig and later under du Parc at the University of Geneva. This long and varied course of stimulating study, combined with frequent vacation work, laid the basis for the deep interest which Finch has maintained throughout his career in the industrial application of scientific knowledge and advances. After serving as assistant research chemist under the late Sir Robert Robertson at the Royal Arsenal in Woolwich, Finch, early in 1913, joined the late Prof. W. A. Bone as his demonstrator in the newly formed Fuel Department at the Imperial College, where, except for absences during the two World Wars and with the 1922 Mount Everest Expedition, he has remained as lecturer, assistant professor in electro-chemistry and (since 1936) professor of applied physical chemistry for nearly thirty-nine years.

As might be expected from his comprehensive early training, Finch's researches have ranged over many fields. Under Bone's influence he first turned towards the efficient use of coal and its by-products, safety in mines and catalytic combustion, and these interests were reflected in his early researches on the ignition and combustion of gases. His recognition of the vital part played by surface structure in heterogeneous catalysis led him to the study of surfaces by electron diffraction, a technique with which his name is internationally associated, and which he has applied to the examination of a wide range of chemical and physical problems. This work was recognized by his election to the Francqui chair in the University of Brussels during 1937–38 and, in conjunction with his important fundamental work on the electrical ignition of gases, by the award of the Hughes Medal of the Royal Society in 1944. In his new sphere Prof. Finch will find ample opportunity to pursue his many interests in the field of applied chemistry to the advantage of Indian economy.

Institute of Welding: New President and Vice-President

At the annual general meeting of the Institute of Welding, held at the Institution of Civil Engineers on July 22, Mr. A. Robert Jenkins and Mr. H. B. Fergusson were installed as president and vice-president, respectively, for the year 1952–53. Mr. Jenkins is a graduate in mechanical engineering of the University of Sheffield, and after his apprenticeship entered in 1931 his family business of Robert Jenkins and Co., Ltd., of Rotherham. He is now deputy managing director of the firm and also, since 1946, works director, in which position he is responsible for the whole of the production and technical side of a works now producing about a thousand tons of fabricated products a month. Mr. Jenkins has travelled widely, visiting factories in Sweden, Germany and the United States, and was a member of the Specialist Productivity Team on Welding which visited the United States in 1950. Mr. Fergusson was educated as a mining engineer in Freiberg, Germany, and later had a distinguished career in railway construction and other engineering projects in Canada, Spain, South America and Russia, where during the First World War he was in charge of 750 Canadian railway-men building the Murmansk Railway. For the past fifteen years he has been a director of G. A. Harvey and Co. (London), Ltd.

University College of the West Indies: New Principal

Dr. W. W. Grave, registrary of the University of Cambridge since 1943, has been appointed principal of the University College of the West Indies in succession to Sir Thomas Taylor, who has been elected principal of the University College of the South-West of England, Exeter. He is expected to take up his new duties in 1953. Dr. Grave was educated at King Edward VII School, King's Lynn, and at Emmanuel College, Cambridge. He took his B.A. degree in 1924, after being placed in the first class in both parts of the Modern and Medieval Languages Tripos. He was elected Fellow of Emmanuel College in 1926, and was a tutor of the College during 1936–40. In 1936 he was appointed University lecturer in Spanish, and during 1940–43 was a temporary administrative officer in the Ministry of Labour and National Service.

British Standards Institution: New Appointments

At the annual general meeting of the British Standards Institution, held at 24 Victoria Street, London, S.W.1, on July 23, it was announced that Mr. John Ryan had been elected chairman by the General Council in succession to Sir Roger Duncalfe, who has completed his three-year term of office. At the meeting Viscount Waverley was re-elected president of the Institution for the third year, and Sir Roger Duncalfe vice-president. Sir Roger, who has been chairman of the Institution during three years of most rapid growth, is widely known in industry as the chairman of British Glues and Chemicals, Ltd. He is also a past chairman and past president, and now a vice-president, of the Association of British Chemical Manufacturers, and a vice-president of the Federation of British Industries. Previously in the Institution he had been chairman of the Adhesives Industry Standards Committee and of the Finance Committee. Mr. J. Ryan is vice-chairman of the Metal Box Co., Ltd., and has for many years played a leading part in the standardization policies implemented through the British Standards Institution by the packaging industry. He was appointed chairman of the Packaging Standards Committee on its formation in 1941 and was intimately concerned with the development of the war-time Packaging Code, which resulted not only in great economies during the Second World War but has also been of much importance to British industry in peace-time, particularly in the export field. Since 1948 he has been chairman of the Institution's Finance Committee. Widely known as an expert in company finance and administration, Mr. Ryan is a member of council and a Fellow of the Royal Statistical Society and holds senior offices in many trade organizations and the British Institute of Management.

University Degrees in Nutrition and Household Science

Courses for the two new degrees of B.Sc. (Nutrition) and B.Sc. (Household Science) will start at King's College of Household and Social Science (University of London) in October 1953. These degrees will replace the present degree of B.Sc. (Household and Social Science). The B.Sc. (Nutrition) degree is designed to make available for the first time in Britain an integrated course in this relatively new science. The course will include a study of food production, taking into account such factors as climate, soil, pests and diseases; food processing and preparation; food chemistry; food consumption and its economic and social deficiency. It will be a valuable preparation for those who intend to go in for nutritional research, to become dietitians, or to take up advisory and research posts with international or national organizations, with local authorities and other bodies which are increasingly undertaking work on the problems of nutrition. The course for the degree of B.Sc. (Household Science) will comprise work in the practical and scientific aspects of the preparation of food, the chemistry of food-stuffs, the principles of institutional management and house planning, and other subjects which come under the general title of household science, with a background of chemistry, physiology and other allied sciences. It is designed to meet the same sort of requirements as the present course for the degree of B.Sc. (Household and Social Science) and will be specially suitable

for those who intend to make their careers in the teaching of domestic science, in institutional management, and in various branches of scientific research.

Sub-Fossil Hekla Pumice from Denmark

Prof. A. Noe-Nygaard has written a paper on the "Sub-Fossil Hekla Pumice from Denmark" (*Medd. Dansk Geol. For.*, 12, Heft 1, 35; 1951), in which is reproduced a photograph showing immense fields of drifting pumice in the sea off the Westmann Islands only a few days after the beginning of the Hekla eruption of March 1947. Hekla and several other volcanoes in the south of Iceland have emitted many flows of a uniform type of oversaturated glassy basalt; but investigations during the past decade have proved that intermediate to acid rocks are also represented to a considerable extent in the Hekla volcanic area, and that lavas and ashes of like composition, especially andesitic pumice, were ejected during the eruption of 1947. Prof. Noe-Nygaard has investigated the finds of sub-fossil pumice which have been made at three places in North Jutland. This pumice is of intermediate composition and is almost identical in chemical composition and petrography with andesitic pumice and ash from the recent eruption of Hekla, as well as with similar finds of sub-fossil pumice on the coasts of western Norway, Novaya Zemlja, Spitsbergen and Greenland. It is therefore taken as highly probable that these pumices were derived from former eruptions of volcanoes in the Hekla region. A question thus arises as to the age of the beds in which the sub-fossil pumice has been found. In Jutland the pumice fragments are associated with rolled pieces of wood, lignite, hazel nuts, small pieces of amber, and one fragment of dopplerite—all light materials capable of floating in currents and liable to drifting and stranding on coasts. One of the beds is covered with peat of the Sub-boreal period. In western Norway the pumice bed is found on the uppermost *Tapes*-line, by which the time of the eruption that supplied the pumice can be fixed at about 2000 B.C. Hence it is probable that four thousand years ago the Hekla volcanoes were erupting material of a nature and composition similar to their present products. Prof. Noe-Nygaard finally envisages the possibility of establishing a synchronous level in the Quaternary beds of several Atlantic coasts by means of the Hekla pumice, in addition to the pollen analyses and archæological considerations which have hitherto been used for chronological purposes.

Ornithological Congress at Bamburgh

A British ornithological conference was held at Bamburgh, Northumberland, during June 26–July 1, under the joint auspices of the British Ornithologists' Union and the British Trust for Ornithology, local arrangements being in the hands of Dr. E. A. R. Ennion, director of the Monks' House Bird Observatory and Field Centre. Emphasis in the programme was on the field excursions. Members of the conference were able to visit the Farne Islands, which are National Trust bird sanctuaries with unique sea-bird colonies, and other interesting half-day visits were paid to Hulne Park, Alnwick, and to Chillingham and Ross Castle, where there is a memorial to Lord Grey of Fallodon. An all-day excursion was made to the Cheviot to see Northumbrian moorland habitats, and various short excursions were also made by small parties to other interesting localities. It is believed that at least 110 species were identified in the field during the conference, a striking indication of the wealth and variety of bird-life in north Northumberland. The indoor sessions, which took place in the Pavilion immediately below Bamburgh Castle, a setting specifically enhanced by the presence, on the rock face above, of several pairs of nesting fulmars, consisted of three discussions, six papers and two illustrated talks. The discussions, on fighting and threat in birds, on visible migration and on sea-bird populations, were led by Dr. N. Tinbergen, Colonel R. Meinertzhagen and James Fisher, respectively. The titles of the papers were as follows: high-water-mark ecology (E. A. R. Ennion), observations on the hawfinch (Guy Mountfort), the work of the Madingley Ornithological Field Station of the Department of Zoology, University of Cambridge (W. H. Thorpe), observations on the lapwing (K. G. Spencer), Northumberland birds (G. W. Temperley) and paper-tearing by birds (W. M. Logan Home). For his talk on "The Ornithological Year in Yorkshire", Mr. Ralph Chislett used some of his own fine collection of slides, and the other talk, on "The Pied Flycatcher at the Nest", by Bruce Campbell, was illustrated with slides from photographs by John Markham. In addition, members were entertained during one evening by Dr. and Mrs. Ennion at Monks' House, where the various trapping devices and other equipment of the Bird Observatory were demonstrated.

French Bibliographical Digest: Physics and Chemistry

Nos. 7 and 8 of "The French Bibliographical Digest", which have recently been issued (No. 7, pp. 87; No. 8, pp. 72. New York: French Embassy, 1951), deal with physics and chemistry respectively and complete the first series of bibliographical digests devoted to scientific works published in France during 1940–48. Several works published in the French language by Belgian and Swiss men of science are also included. A second series will list works published during 1949–51. The booklets contain, in addition to a useful list of the appropriate French scientific periodicals and publishers' addresses, the titles, with full bibliographical references, of the more important physics or chemistry books of university or more advanced standard. The inclusion of doctorate theses is most valuable. Many of the titles are accompanied by reviews, in English, reprinted by permission from British, American and French scientific journals. No prices are quoted because of the rapid fluctuations in exchange value. Prof. Y. Rocard, a member of the advisory board of the "Digest", contributes an introduction to No. 7, in which he describes briefly the effects of the German occupation on French physical research. He pays tribute to the many physicists, including H. Abraham, E. Bloch, G. Bruhat, F. Holweck, L. Cartan and J. Solomon, who died either in concentration camps or because of their participation in the resistance movement. Finally, he surveys briefly post-war activities and mentions the various French laboratories and the branches of research being pursued there. The chemistry booklet is similar in lay-out to the one on physics. The arrangement is alphabetical by authors under the following headings: chemistry, general; organic chemistry; inorganic chemistry; analytical chemistry; physical chemistry; industrial chemistry, technology and metallurgy; colloid chemistry; and biochemistry. Librarians, as well as research workers, will find the two booklets extremely useful for reference purposes.

Conception of Science in Education

The summer number of *The Use of English*, edited by Denys Thompson (Chatto and Windus), is notable for the amount of space which it devotes to the problems of teaching the humanities to the science specialist, particularly in the senior forms of grammar and public schools. F. W. Westaway, and more recently P. A. Gaskill and A. Towers, have already written excellent small books on English for science students. The editorial of the periodical under review goes further and gives a most useful outline of a scheme for enlarging the conception of science, its nature, its methods, its strength and its limitations in the field of knowledge. Such a scheme could well be developed for all sixth-formers in addition to those specializing in science. An excellent reading list on the values of science, science and civilization, the scope of science, science and religion, and science and politics is provided. The editor is wise in saying that "every sixth form teacher knows that it is not only the scientist who suffers from lack of balance and humility. In their refusal to see that true science is a major human activity, specialists in other subjects are quite as obtuse and obstinate as any scientist". This, indeed, is exemplified in another otherwise useful contribution by a writer in the same issue, who says: "Western civilisation is not only a weaving together of Greek, Roman and Hebrew strands; for good or ill we must admit the presence of modern western technology". Here again is the failure to realize that technology is a part of the application of science and not science itself. It now remains for some wise educationist to continue the work of redeeming the philistinism of so many students of the arts. Examples of this are only too common: for example, the master of the college who dreams of a neo-Hellenic Utopia but does not despise the use of anæsthetics and aeroplanes and adds to his income by broadcast talks.

National Museum of Canada, Ottawa: Annual Report for 1949–50

The year 1949–50 was an important one in the history of the National Museum of Canada, for it inaugurated a new era. The Museum began and grew up within the Geological Survey; but in 1920 the two were separated and placed under separate directors. They continued, however, to occupy the same building—the Victoria Memorial Museum—and to share some of the same services and even the same administration. By a reorganization which became effective in January 1950, the two passed into different government departments—the Geological Survey into the Department of Mines and Technical Surveys, and the National Museum into that of Resources and Development. This development is recorded in the annual report of the Museum for 1949–50 (Bulletin No. 23; pp. 261+60 pl.; 1951; 1 dollar). As is usual with museums in Canada and the United States, the Museum has been able to carry out an extensive series of expeditions and archæological excavations. The report gives details of field-work in zoology, undertaken in British Columbia, and botanical studies along the east coast of Hudson Bay; archæological sites were investigated on Cornwallis Island, North-West Territories, and in Manitoba and Saskatchewan. It is a matter worthy of note that these field exhibitions are undertaken as part of the normal work of the Museum, such is the faith of the trustees and managing bodies in their ultimate value to the Museum and the common weal.

Research at the University of Birmingham during 1950–51

The twenty-second annual report of the Joint Standing Committee for Research of the University of Birmingham covers the session 1950–51, in which the new Aitchison laboratories in the Department of Industrial Metallurgy were brought into use for teaching and research purposes. These laboratories consist of two main sections equipped with full-scale plant for foundry and for metal-working operations, and there is also a machine shop used principally for the construction of apparatus and for service and maintenance purposes. The laboratories, with modern manufacturing plant and equipment at their disposal, have been constructed and equipped in the hope of supplying the metallurgical industries with men of good metallurgical training. The most valuable feature of the report is, as in previous years, the departmental lists of published work which is regarded as contributing to original knowledge. Each list is prefaced by a short note directing attention to special features of the year's work. Three examples of such special features are as follows: in the Department of Mathematical Physics a new method has been evolved of treating bound states in field theory, which has led to the development of new mathematical methods; work on the dielectric breakdown of pure liquids has now attracted a grant from the Department of Scientific and Industrial Research; and the Department of Chemistry has been selected by the International Union of Chemistry as the British laboratory for the standardization of the molecular weights of high polymers.

University of London

The title of professor emeritus in the University has been conferred on the following: Prof. S. P. Bedson (bacteriology), on his retirement from the Goldsmiths' Company's chair of bacteriology at the London Hospital Medical College which he has held since 1934; Sir David Brunt (meteorology), on his retirement from the chair of meteorology at the Imperial College of Science and Technology which he has held since 1934; Sir Alfred Egerton (chemical technology), on his retirement from the chair of chemical technology at the Imperial College of Science and Technology which he has held since 1936; Prof. G. I. Finch (physical chemistry), on his retirement from the professorship at the Imperial College of science and technology which he has held since 1936; Prof. J. R. Marrack (chemical pathology), on his retirement from the chair of chemical pathology at the London Hospital Medical College which he has held since 1934; Prof. J. A. S. Ritson (mining), on his retirement from the chair of mining at the Imperial College of Science and Technology which he has held since 1935; Sir George Thomson (physics), on his retirement from the chair of physics at the Imperial College of Science and Technology which he has held since 1930.

The following other titles in the University have been conferred: reader in pharmacognosy on Dr. J. W. Fairbairn, in respect of the post held by him at the School of Pharmacy; professor of pharmacology and therapeutics on Dr. C. A. Keele, in respect of the post held by him at the Middlesex Hospital Medical School; reader in biochemistry on Dr. William Klyne, in respect of the post held by him at the Postgraduate Medical School of London; reader in bacteriology on Mr. B. W. Lacey, in respect of the

post held by him at Westminster Medical School; professor of chemical pathology on Mr. N. H. Martin, in respect of the post held by him at St. George's Hospital Medical School; reader in morbid anatomy on Mr. A. D. Morgan, in respect of the post held by him at Westminster Medical School; reader in structural geology on Dr. Gilbert Wilson, in respect of the post held by him at the Imperial College of Science and Technology; degree of doctor of science on F. H. Burstall, P. C. C. Garnham, T. C. S. Morrison-Scott, Prof. Joseph Rotblat, D. B. Scott and Prof. P. E. Vernon.

Centrifuges and pH Meters

As a result of suggestions that existing models of centrifuges and *p*H meters have various and considerable disadvantages, the Institute of Biology is making a survey of the views of biologists on the desirable qualities of such instruments. It is hoped that the information obtained will enable the Institute to make constructive suggestions to manufacturers and will provide guidance for intending purchasers. Copies of questionnaires, one on centrifuges, the other on *p*H meters, may be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Clayton Awards for 1952 of the Institution of Mechanical Engineers

UNDER the terms of the Clayton Bequest, the Institution of Mechanical Engineers has made the following awards for 1952 for special experience, postgraduate studies or research in mechanical engineering, the amounts totalling about £5,200 in value. *Clayton Fellowships:* B. J. Beale (Guildford), J. R. Botterill (Harrogate), F. J. Feltoe (Port Talbot), E. J. Forster (Bromley), P. M. Moreton (Whitchurch), C. E. H. Morris (Swansea), D. J. Myles (Arbroath), H. Naylor (Shipley), J. R. Willetts (Birmingham), R. G. Woolacott (London). *Clayton Grants:* C. K. Gulland (London), J. R. Plant (Burnley), J. L. Raynes (Bournemouth), T. F. Roylance (Allenton).

Institute of Metal Finishing: Endowment of New Awards

THE Council of the Institute of Metal Finishing has recently approved the establishment of the following awards. *Hothersall Memorial Medal and Lecture:* The Mond Nickel Company, Ltd., has endowed the annual award of a palladium medal (with which will be associated a sum of £50) for an initial period of seven years, in memory of the late Mr. A. W. Hothersall; the Council of the Institute will choose the recipient, who will then be asked to deliver a lecture. *Johnson Matthey Silver Medal:* This Medal, which has been endowed by Johnson Matthey and Co., Ltd., will be awarded annually, or at such times as may be decided by the Council, for the best paper presented to the Institute on the deposition of precious metals. *Westinghouse Brake and Signal Co., Ltd., Prize:* An award for the best publication appearing in the *Journal* of the Institute, which, in the opinion of the Publications Committee, shows the most valuable advance in the science or practice of electrochemistry in general and electrodeposition in particular, has been endowed by the Westinghouse Brake and Signal Co., Ltd., for a preliminary period of seven years; it will amount to £25 annually and will consist mainly of a selection of books. In the case of the last two awards, both members and non-members of the Institute are equally eligible, and papers should be submitted direct to the Institute at 32 Great Ormond Street, London, W.C.1.

International Astronomical Union: General Assembly at Rome

THE eighth General Assembly of the International Astronomical Union will be held in Rome during September 4–13. The inaugural ceremony will take place in the Campidoglio, in the Hall of the Orazi and Curiazi, and other sessions will be in the University of Rome and near by in the building of the Italian National Research Council. Besides the various Commission meetings, the programme will include three symposia on stellar evolution, astronomical instruments and the astrometry of faint stars, respectively. In addition, excursions will be made to the Castelli Romani, with a stop at Castel Gandolfo for visiting the Vatican Observatory, and to the archæological excavations at Ostia Antica. Non-members of the International Astronomical Union may participate in the Congress on payment of a fee of 5,000 lire. Further information can be obtained from the assistant secretary-general of the Union, Prof. P. Th. Oosterhoff, Leyden Observatory, The Netherlands.

Beta- and Gamma-Ray Radioactivity: Conference in Amsterdam

A CONFERENCE on beta- and gamma-ray radioactivity, which has been organized by the Netherlands Physical Society with the support of the International Union of Pure and Applied Physics and of Unesco, will be held in Amsterdam during September 1–6 under the presidency of Prof. G. J. Sizoo. The conference will be open to all nationalities and will consist of invited papers of about forty-five minutes in duration, and short communications, to be given by guests or visitors, of about fifteen minutes in duration. The principal sessions and headquarters of the conference will be at the Koninklijk Instituut voor de Tropen, Mauritskade 63, Amsterdam-O: the sectional meeting on the Monday afternoon will be held in the Vrije Universiteit, de Lairessestraat 174, and those on Wednesday and Friday afternoons in the physical laboratories, Plantage Muidergracht 4–6. All the lectures will be published in a special issue of *Physica*. Further information regarding the conference can be obtained from Prof. J. de Boer, Bunsenstraat 98, Amsterdam-O.

Announcements

WE regret to announce the death on August 5 of Sir Jack Drummond, F.R.S., director of research to Boots Pure Drug Co., Ltd., and of Lady Drummond, both well known for their work on human nutrition.

PROF. PAUL KARRER, professor of organic and practical chemistry in the University of Zurich, has been elected a foreign associate of the Paris Academy of Sciences in succession to the late Sir Charles Sherrington; Prof. Maurice Fréchet, honorary professor in the Faculty of Sciences, University of Paris, has been elected *correspondant* for the Geometry Section of the Academy in succession to the late Prof. G. Castelnuovo.

DR. S. KRISHNA has been appointed deputy director of the Council of Scientific and Industrial Research, New Delhi, on the expiry of his term of office as Scientific Liaison Officer for India in Great Britain.

PROSPECTING BY GEOPHYSICAL METHODS

THE European Association of Exploration Geophysicists held its second meeting at Manson House, London, during May 22 and 23. About ninety members and visitors attended, half of whom came from abroad. The Society of Exploration Geophysicists of the U.S.A., with which the Association has close ties, was represented by its official delegate, Dr. Alexander Wolf, of Houston, Texas, and the chair was taken, in turn, by the president, Mr. van Weelden (Netherlands), and Mr. G. Westby, president of the Seismograph Service Corporation of the U.S.A. Nine technical papers from France, Germany and Great Britain were presented. Four of these related to seismic prospecting, three mainly to gravity and two to the telluric current method.

In a paper presented by Mr. H. Linsser (Germany) the author attempted to explain, in a simple manner illustrated by diagrams, the mechanisms of a seismic explosion, and to decide which phases of the explosion contribute to the seismic energy propagated. His investigations were supported by experiments, and he has come to the rather surprising conclusion that no perceptible ground motion is set up by a rarefaction wave following the initial compressional impulse. The latter creates a zone of deformation within which the rock medium is stressed beyond the elastic limit and compressed: and apparently this zone assumes a permanent set which withstands the rarefaction rebound.

The significance of diffraction in the detection and mapping of faults was the subject of a paper by Mr. T. Krey (Germany). By theoretical treatment and field observations, Mr. Krey has demonstrated that the overlapping on a seismic record of reflexions from a faulted bed is not necessarily due to thrust faulting or, in the case of a normal fault, a difference in dip of the bed on either side of the fault: it can be due to the effect of diffraction at the edges of the faulted bed. The attenuation of the energy of the diffracted waves with distance from the fault is gradual, and makes precise location of the fault a difficult problem. When employing the customary interpretation technique, the error involved could be of the order of hundreds of feet, and depends on the depth of the reflecting bed and the signal-to-noise ratio of the seismic recording. Errors may also result in the determination of dip.

In stressing the importance of this paper, Dr. A. Wolf suggested that the practical implications of diffracted waves in seismic prospecting were not fully appreciated. He had been able to register them by using geophones connected in opposition and placed 200–300 ft. apart. With such an arrangement the normal reflexions would not be recorded; but waves diffracted at a fault would arrive at the two geophones out of phase and would be registered. In this way he had successfully located faults in the United States.

Mr. J. Goguel (France) described a special slide-rule which he has developed for the rapid determination of the depths of a series of refracting beds, with small dip, from the observed time-curve. The design of the slide-rule is based on the 'intercept time' method of depth calculation and, when adjusted for the velocity values determined from the time curve, it furnishes directly the cosine factors which are required in the depth formulæ.

Laboratory investigations on the variation of the elastic constants of rocks with frequency were described by Prof. J. M. Bruckshaw and Mr. P. C. Mahanta (Great Britain). It is an established fact that there is an appreciable difference (up to 20 per cent) between the statically determined elastic modulus and the effective value at high frequencies, and the experiments described were designed chiefly to secure further information on this change. American investigators have demonstrated that no appreciable change occurs over the frequency-range 140–4,500 c./s., and the authors' investigations were therefore confined to a lower region, between 40 and 120 c./s.

Measurements made on six different rock specimens exhibited a gradual increase of Young's modulus with frequency, but the total increase over the frequency-range employed was only 2·1–2·6 per cent. The trend of the curves suggested that considerably greater changes could be anticipated below 40 c./s. The authors made use of the results to demonstrate the magnitude of the internal dissipation of energy over the frequency-range considered and were able, also, to show that the influence of dispersion in seismic prospecting is unlikely to cause appreciable error in the interpretation of field seismograms.

Much attention has been paid in recent years to the problem of securing the maximum information from gravimeter observations by devising improved methods of removing the effect of the 'regional anomaly'. Papers relating to this problem were presented by Dr. O. Rosenbach (Germany) and Dr. V. Baranov (France).

The former described a development of the 'second derivative' method of interpretation originally published by T. A. Elkins[1]. Dr. Rosenbach explained that Elkins's formula, while applying quite satisfactorily to deep-seated structures which give rise to low fluctuations of the second derivative at surface, cannot handle adequately the more extreme variations of the second derivative which result from density anomalies at shallower depths. The new approach which he described is to expand the gravity values at suitably spaced points on concentric circles as series in G_P (the gravity at the centre) and its derivatives. By combining sets of these series he has derived practical formulæ which furnish a very close approximation to the theoretical curve for the second derivative.

Dr. V. Baranov presented an interesting analytical method of determining the regional anomaly. The problem in practice is to divide the Bouguer anomaly, B, into two component parts, $B = R + A$, R being the regional anomaly and A the sum of the residual anomalies. The isogals which define the regional gravity anomaly should exhibit only slight curvature and should be fairly regularly spaced. Dr. Baranov therefore assumes that the anomaly can be expressed as an analytical function which may be expanded in a power series, and he neglects terms beyond those of the second or third degree. In order to determine the coefficients of this function, he utilizes the con-

dition that the residual anomalies, A, have only a very limited influence, which implies that the integral

$$\psi = \iint (B - R)^2 \, dx \, dy,$$

over the area within which the regional anomaly is required, is a minimum. A complete description of the method was presented, and illustrated by practical examples.

The discussion which followed these two papers on gravity was very lively, and some speakers, led by Prof. Vening Meinez, expressed their doubts of the real practical value of the various methods which attempt to eliminate the 'regional effect' from the Bouguer picture. Dr. Rosenbach, in his reply, emphasized the importance of an appreciation of the scale of the problem in gravity prospecting. It must be realized that a very close network of stations is adopted, and that the modern gravimeter can be read with an accuracy of at least 0·1 milligal.

Prof. K. Jung (Germany) described two elegant geometrical constructions for determining the approximate positions of buried bodies of simple form from their gravity or magnetic anomalies. He explained that these constructions were developed for use by geologists and others with a restricted mathematical background who require to assess roughly the results of a geophysical survey. He described also a simple mathematical development of Nettleton's method of determining near-surface densities from a series of gravity observations along a profile over a topographical feature.

The telluric current method of prospecting has been developed and used with considerable success by French geophysicists. A paper by Mr. M. Mainguy and Mr. A. Grepin (France), describing some practical examples of interpretation of telluric maps obtained in Languedoc (south-east France), was written from the point of view of a geologist, and was therefore of particular interest. The results of telluric surveys in the Beziers and Alés–Maruéjols basins and the Lunel area were described, and compared with gravity and seismic investigations in the same areas.

The outstanding feature of this particular geophysical work is that, in general, the telluric method has apparently furnished more detailed and accurate information than any other method. In the case of the Alés–Maruéjols survey, the results of the telluric observations contradicted to a considerable extent the prevailing geological ideas and the findings of other geophysical methods; but subsequent drilling evidence confirmed the accuracy of the telluric interpretation and resulted in the discovery of oil. In the Beziers basin the telluric results agreed quite well with the gravity findings, but, in common with the seismic work, the method was unable to secure detail from the depths required. The survey in the Lunel area was very difficult to interpret, but despite this the telluric method appears to be the most promising one to employ.

Mr. G. Kunetz (France) dealt with the problem of eliminating the effect on telluric observations of stray earth currents originating from installations such as electric railways, tramway systems, etc. For surveys where the source of disturbance is, say, a large industrial town at a considerable distance, it is possible to represent the disturbing field approximately by a function the parameters of which can be determined experimentally. A 'regional anomaly' map can thus be produced. Where the disturbing source, or sources, are in the immediate proximity, and the parasitic currents are liable to violent fluctuations, much more laborious methods are required, involving numerous field measurements. It speaks highly of the work of our French colleagues that it has been found possible to produce telluric maps of practical value in such difficult circumstances.

D. T. Germain-Jones

[1] *Geophysics*, **16**, 1, 29 (1951).

CONFERENCE ON FERTILITY

THE scientific proceedings of the third annual Conference on Fertility, held by the Society for the Study of Fertility in London during June 27 and 28, were opened by Dr. Carl G. Hartman (United States), who presented formidable evidence for the theory of germ-plasm defect as a major cause of fœtal wastage. His early studies on the aplacental opossum, in which he found some 10 per cent of all the developing eggs to be grossly faulty, led him to favour the view put forward by Streeter—that early death of the embryo was due mainly to defective germ plasm—rather than the older idea of Mall that implantational defects were chiefly responsible. Later studies on mouse eggs, using intra-vital staining techniques, supported the same view by demonstrating, in many instances, dead and living blastomeres within the same zygote. He referred also to the recent studies by Hertig and Rock of early human ova; in none of the cases wherein these were abnormal did the authors find any evidence of endometrial deficiencies, although Dr. Hartman admitted that Hughes has claimed that a lack of a glycogen could be demonstrated in the endometrium in some cases of early abortion.

Prof. S. A. Asdell (United States) gave a provocative contribution on the effect of intelligence upon fertility, basing his conclusions on a study of the pedigrees of royal houses. Although the assessment of 'intelligence' was made as objective as possible, he admitted the possibility of many sources of error. Nevertheless, with the exception of genius, which appears to make its own laws, definite correlations appeared to exist, many of which were contrary to popular beliefs. Thus, although the incidence of inbreeding decreased with rising intelligence, the proportion of childless marriages was highest with least intelligence and smallest with average intelligence, and the number of children in the family was highest with average intelligence. It seemed that Nature favoured the average in intelligence, as in most other biological attributes. Another finding was that, contrary to Galton's view, the families of only children of high intelligence (judges who had been elevated to the peerage in Stuart and Georgian times) tended to be large, averaging five to six offspring. Naturally, this paper evoked lively discussion.

Prof. S. Zuckerman (Birmingham) reviewed the cellular components of the ovary, particularly from the point of view of their plasticity. He referred to his own recent work, which leads him to conclude that, in the rat at least, no formation of new oocytes from the germinal epithelium occurs in the adult. He considers the function of the germinal epithelium to be mainly protective; it is highly phagocytic and resilient, continually changing in size and shape as follicles mature and corpora lutea develop and regress. He stressed its sensitivity to trauma, to which it responds vigorously by the formation of

ingrowths and outgrowths. The other highly plastic element of the ovary is the theca interna cell, which transforms from a fibroblastic cell into an epithelioid secreting cell, luteinizes to become—very likely—the only functional endocrine element of the corpus luteum, and finally can become transformed back into a fibroblastic structure.

Dr. Henri Bayle (Paris) discussed spermatophagia in the human epididymis in cases of excurrent duct obstruction and showed slides of spermatorrhage—rupture of the epididymal tubules through excessive internal pressure, with outflow of spermatozoa into the peritubular spaces, leading to obliteration of the epididymal canal. He then demonstrated his film showing the operative technique of vaso-epididymostomy; the beauty and lucidity of this film are beyond description. Dr. Bayle does not perform testicular biopsy first, but prefers to incise the head of the epididymis after having mobilized the testicle; if moving spermatozoa are seen in the epididymal fluid, he proceeds with the operation, provided patency of the vas deferens can be demonstrated. He uses seven sutures of fine tantalum wire to anastomose the vas to the epididymis. Delicacy of touch and the avoidance of trauma are the prime requisites of success in this difficult operation. Out of 143 cases explored surgically, anastomosis was found impossible in thirty cases, and in a further six congenital absence of the vas was discovered. Vaso-epididymostomy was performed bilaterally in sixty cases, and unilaterally in forty-five; in a further four cases anastomosis of the vas deferens direct to the testicles was attempted. Of sixty-five surgically satisfactory cases, the azoospermia was cured in forty-five (66 per cent), twenty of these men producing in all thirty-two children. This rate of success, of course, is far better than any other surgeon has achieved.

The morning of June 28 was devoted to a symposium on spermatozoan morphology; this was opened by Prof. L. Harvey (Exeter), who gave a review of spermatogenesis and spermateliosis. The National Institute for Medical Research team of workers (C. F. Challice, P. E. Lake, E. J. C. Polge and J. Smiles) reported ultra-violet microscopy studies on living fowl germ cells and electron-microscope studies of mouse and rabbit spermatozoa. They showed how the Golgi zone of the fowl spermatid developed into the acrosome. The tail filament was found to be motile from the earliest stage, the tail granule being the source of motility. Chromosome material aggregates, becoming a homogeneous mass within the nuclear membrane. It then elongates, later to shrink, leaving behind a free portion of the nuclear membrane, thus forming the manchette which later forms a rigid tube around the first part of the tail. Considerable advances in our knowledge of the morphology of rabbit and mouse spermatozoa have been afforded by the technique developed by these workers of cutting sections 0·2 μ thick followed by electron microscopy. There is strong evidence for a double spiral structure of the mid-piece and tail around the axial filament, all within a fine outer membrane. The axial filament contains nine fibrils arranged circularly around a central one, and there appears to be a flange running lengthwise down the tail.

Mr. Geoffrey Grigg (Cambridge) also contributed electron-microscope studies on fowl spermatozoa, his findings being mainly in agreement with those of the previous speakers. The apical cap dissolves in distilled water, leaving the apical spine partly embedded in the head. He has regularly found eleven fibrils in the axial filament—two central and nine outer. There seems to be an inner core to each fibril which is more elastic and more resistant to tryptic digestion than the surrounding material. Dr. Bayle showed electron-microscope photographs of human spermatozoa. Dr. John McLeod (United States) discussed spermatozoan morphology in relation to human fertility and, as a result of his large-scale studies, he has come to the conclusion that little correlation between sperm morphology and fertility can be discovered in the human. Poor morphology is commonly associated with poor motility—which has a very definite bearing on fertility—but otherwise, provided the sperm density exceeds 20 millions per ml. and the percentage of active cells is not much below 40, fertility seems to depend mainly upon the quality of sperm motion.

Dr. John Wilkinson (Exeter) described the effects of aspermy virus upon nuclear behaviour in solanaceous plants. In the pollen and embryo sac mother cells, the pachytene threads become disorganized in the prophase of meiosis and the nucleoli are multiplied. Some of the chromosomes fail to pair, leaving behind univalents at metaphase and anaphase. This probably accounts for the 25 per cent diminution in seed production shown by affected plants. It was suggested that a competition may exist between the virus and the chromonematal material of the chromosomes for ribose-nucleic acid. Mrs. C. Harvey (Exeter) said she had made similar observations on testicular biopsy material from subfertile men, having also noted collapse of the chromonemata at prophase and loose and lagging chromosomes at metaphase and anaphase. This seemed to suggest a possible viral etiology for some cases of human male infertility.

In the last two papers, Dr. F. X. Gassner (United States) showed that the rate of fructolysis in seminal fluid is better correlated with the breeding efficiency of bulls than the conventional criteria of seminal analysis, and Dr. E. W. Macmillan (Liverpool) described the vascular pattern of the epididymis in the rat and the sequence of changes in the epididymis and testis following interruption of the superior epididymal and accessory capital arteries; the vasa efferentia became packed with spermatozoa, which led to their gross enlargement and to severe degenerative changes within the testis, while the caput epididymis underwent necrobiosis followed by obliterative fibrosis.

EMULSIONS AND FILMS

SYMPOSIUM AT SHEFFIELD

THE British Society of Rheology organized a symposium on "Emulsions and Films" which was held in the University of Sheffield during March 28–29. All the papers were followed by discussion, and on the second day the meeting visited the chemistry laboratories of the University and inspected the apparatus used by the speakers at the meeting.

In the first paper, Dr. A. S. C. Lawrence pointed out that emulsions are always placed in a separate category of colloids as liquid-in-liquid systems—a classification to which objection can be made on two grounds: the fact that the liquid state of the disperse phase makes possible dispersion by shaking is of no fundamental importance (it is not even true for

dispersions of true colloidal size, that is, oil hydrosols which are typical hydrophobic systems); and it has distracted attention from the really basic criteria—namely, that, although hydrophobic, very high concentrations (74 per cent) of the disperse phase are easily attained, and the particle size is much larger than in all other hydrophobic colloidal solutions. Emulsions are not, strictly, colloids at all; they are opaque, and sedimentation, as creaming, is one of their most distinctive properties. They belong, in fact, to the neglected class of protected colloids.

It has become accepted that the stability of emulsions is due to the lowering of the free surface energy of the system by adsorption of surface-active emulsifying agent and that interfacial tension is a 'coagulating tendency'. This error of identifying the potential reduction of free energy with the driving force causing the reduction is one against which students learning thermodynamics are warned year after year. In any case, a lowering of the free surface energy can reduce only potential instability and cannot give an absolute stability: even if this thermodynamic quantity were the driving force in coagulation, reduction to zero would be required to give absolute stability. This, however, is the condition for miscibility of the two phases, and it is also a characteristic of emulsions that there is some residual interfacial surface tension which is responsible for the spherical shape of the droplets of the disperse phase. The emulsifying agent should be regarded as an energy barrier which is needed, as in all hydrophobic systems, to prevent aggregation or coalescence of particles subsequent to collisions due to their Brownian motion. The action of the energy barrier is to prevent coalescence following collision; it has no effect upon collision frequency. The mean Brownian velocity depends upon T and inversely upon η—that is, the viscosity of the continuous phase and not that of the whole emulsion, which is always larger, usually by a large factor. Collision frequency will be highly dependent upon concentration obviously as a function of the cube root of it, since it is dependent upon the mean distance of separation of the droplets, all other factors being the same. Creaming will always increase collision frequency because it reduces the mean separation distance. For fine dispersions, Brownian motion is the rate-determining factor in the collision process but, as particle size increases, sedimentation becomes increasingly the rate-determining factor. Every chemist has had the opportunity of seeing this transition every time he has done an ether extraction. This kinetic picture must be extended because there will be a Maxwell distribution of Brownian velocities, and the number with sufficient energy to overcome the energy barrier to coalescence, E, will be given by the usual $n/n_0 = \exp(-E/RT)$. 'Stability' means that n/n_0 is vanishingly small.

Surface tension has no place in this scheme; it determines the work to be done in dividing the disperse phase; it has nothing to do with the stability of emulsions. Adsorption of the emulsifying agent to the interface requires that it must lower the interfacial tension, but this lowering need not be large. It could be said that surface tension is involved in the coalescence stage in breaking: since, however, the first step in coalescence must involve an increase of the surface area of two spherical drops, it would appear that high interfacial tension will resist this step while a low value favours it and, therefore, instability—again, this is the opposite to the accepted view that low interfacial tension favours stability.

The energy barrier provided by the emulsifying layer may be electrical, mechanical or due to surface tension. The last-named class consists of powders acting by a differential wetting-angle with the two phases. Amphipathic substances which are also ionized may be good emulsifiers but some are not. It therefore seems that some other property is concerned, and Dr. Lawrence suggested that this is viscosity; either a high two-dimensional η or a plasticity. It is likely, but not proved, that objection may be made against rigidity in the sense that, when such a layer is fractured, it cannot spread again to close a gap. Dr. Lawrence's emulsions of sea water in fuel oil are a case in which very high surface viscosity, without a charge and with very slight surface activity, is responsible for stability.

The work carried out in Sheffield which Dr. Lawrence reported to the meeting is based upon the following idea. The viscosity of the continuous medium may be increased and therefore reduce ξ and, therefore, collision frequency, but this is only a reduction: it cannot give absolute stability in a liquid system. The high and anomalous viscosity of an emulsion of 50 per cent or more oil in soap solution is an indication of the surface viscosity of the emulsifying layer: laminar flow requires droplets to slip between their neighbours and, to do so, they must be distorted into ellipsoids; if, after passing, they relax to spheres before the next passage, the work used in deforming them will be dissipated as a micro-turbulence of the liquid medium associated with the flow of the droplet, and non-Newtonian flow will result. One immediate result is that the extent of the anomalous viscosity will be proportional to the surface area of the drops; that is, inversely proportional to their diameter. Direct measurements have been made of the surface viscosity and plasticity of solutions of soaps with various polar groups.

Other researches in progress at Sheffield are an investigation of the kinetics of coagulation using micro-photographic recording with phase-contrast objectives—no method exists for assessing the stability of emulsions other than counts of particle size. Some less laborious method is urgently needed and is under consideration. ζ potentials are also being studied, and a drop-profile apparatus is being used for measuring interfacial tensions, especially when small. The work is being extended to the action of complexes of soap plus a molecule containing a polar group such as carboxyl, hydroxyl or amine.

The present views upon which the work is proceeding are fourfold: that best emulsifying efficiency requires the closest packing of the soap molecules at the interface; that soaps alone are not the best emulsifiers (carboxylates are an apparent exception because the acid soap is the useful agent); that closest packing and maximum efficiency are provided by complexes of soaps (of all sorts) and molecules containing a hydrocarbon chain of not less than six normal carbon atoms and a polar group such as hydroxyl, carboxyl or amine; and that these complexes, at sufficient concentration in bulk, are all liquid crystalline of the smectic type.

Mr. E. Rothwell (University of Sheffield and Imperial Chemical Industries, Ltd., Ardear) reviewed the work of Hatschek and Sibree and the later empirical relations between η and concentration proposed by Richardson, Broughton and Squires and by Goodeve. He then mentioned the work of Rossi, Lyttleton and Traxler and of Richardson upon the effect of particle size upon η. He described his own

experimental work with particular reference to the effects of the packing-density in the emulsifying layer, to the effect of particle size and to the composition of the soap adsorbed at the interface. η was inversely proportional to particle size diameter for a given physical state of the emulsifier layer. For a given particle size viscosity decreases with increase of area per molecule adsorbed—that is, viscosity increases with increase of packing density, and therefore with fall of interfacial tension. This proves that the work done in flow in deforming droplets is not work done against γ, since that would require η to vary with γ in the opposite sense to that found, and the work must therefore be done against a surface viscosity, plasticity or elasticity. In agreement with Hatschek, it was found that, at very low rates of shear, η is independent of rate of shear corresponding with a complete relaxation of droplets between successive distortion; η then falls with increase of rate of shear but becomes constant again at high values corresponding with permanent distortion during flow.

The next speaker, Mr. B. C. Blakey (University of Sheffield), described measurements of the surface viscosity of soap solutions by the oscillating bob method. Sodium carboxylates, sodium alkyl sulphates and kationic soaps all have a high surface viscosity which is non-Newtonian except in the *n*-alkyl sulphates: the kationic soaps developed surface viscosity only on standing. The minimum concentration for appearance of surface viscosity is well below the critical concentration: in the carboxylate series, η rises with increase of chain length at 20° C. Sodium soaps have a higher value than that for potassium compounds. The effect is very large; for solutions of sodium cetyl sulphate the viscous drag on the bob due to the surface viscosity is equivalent to an immersion in water of the bob of 2–5 in.

The greatest care needs to be taken to exclude impurities even in very minute concentrations, and fractionation by frothing is especially valuable as a check. The addition of fatty acid to a carboxylate soap causes surface viscosity to appear at lower concentration than for the soap alone; but alkali has the opposite effect, which suggests that the surface species is acid soap. Alkyl trimethylammonium soaps showed a pronounced maximum at the critical concentration, the most obvious explanation of which was impurity which was solubilized at the higher concentrations. This has since been confirmed. A solution sufficiently pure to show no minimum in the surface tension concentration curve did give a maximum in the surface viscosity curve, and surface viscosity is therefore a more sensitive method for detection of small amounts of impurity than is surface tension. The sodium alkyl sulphates show Newtonian surface and interfacial viscosities when pure, but anomalous when not rigorously purified.

Work on solubilization of substances such as alcohols and fatty acids upon soaps was described by Mr. A. J. Hyde (University of Sheffield). This differs from solubilization of hydrocarbons in two fundamental respects: the inert substance in excess passes to emulsion, the polar addition, as soon as excess is added, separates with the soap as a liquid layer, the other being water, and the soap additive complex becomes oleophilic; at sufficient concentration and with a longer hydrocarbon chain in the additive, liquid crystals of the smectic layer type are always formed. The texture of the smectic phase varies with the composition giving either anisotropic spherulites, Dupin's cyclides or myelinic figures. The last are usually of the normal curved form, but occasionally have sharp angles as if simulating crystals. The general scheme seems to be:

spherical micelle in soap solution + additive → smectic layer complex

With less hydrophobic additive, for example, benzyl-alcohol, considerable further lowering of surface tension occurs, paralleled by charges of electrical conductivity. This lowering of surface tension must mean closer packing in the adsorbed film. With these more hydrophilic complexes, emulsification does not take place.

In a theoretical paper on the rheological behaviour of an emulsion, Dr. J. G. Oldroyd (Research Laboratory, Courtaulds, Ltd., Maidenhead) described how a finite interfacial tension between the two phases must give rise to elastic as well as viscous properties, since it provides a force tending to restore each deformed droplet of the disperse phase to its original spherical form. On the assumption that the droplet size is sufficiently small and uniform, an equation of state for a dilute emulsion subjected to small rates of strain was derived in the form of a linear relation between stress, rate of change of stress, rate of strain, and rate of change of rate of strain. The three constants in the equation were expressed in terms of the viscosities of the two phases, the interfacial tension and the volume concentration. The predicted effect of introducing a stabilizer would be principally to increase the relaxation time and retardation time of the system (by decreasing the interfacial tension) without changing the viscosity. But if hydrodynamic slipping were possible at the droplet boundaries due to the presence of a film of stabilizer, all three constants would be affected; preliminary calculations showed that it might be very difficult to detect slipping of this kind experimentally.

A. S. C. Lawrence

SECOND SEMINAR FOR EUROPEAN SANITARY ENGINEERS

The second seminar for European sanitary engineers, sponsored by the Italian Government, the Rockefeller Foundation and the United Nations World Health Organization, was held in Rome during November 1951; representatives from sixteen European countries attended. The report of this meeting, published by the World Health Organization*, contains a great deal of information, which has not hitherto been easily available, on sanitary conditions on the Continent.

There was general agreement that there should be closer collaboration between sanitary engineers in different European countries. Many rivers, for example, flow through more than one country before reaching the sea, and it is clearly desirable that the discharge to them of polluting substances should be controlled in the common interest. The problems which arise in this kind of international planning are, of course, partly political, but are more likely to be solved if there is general agreement on the technical issues involved. At present the importance of the

* World Health Organization. Second Seminar for European Sanitary Engineers, Rome, 11–17 November 1951. Pp. v+280. (Geneva: World Health Organization, 1952.)

profession of sanitary engineering differs a good deal from country to country, and there is no general agreement on what the basic training of a sanitary engineer should be. Generally, however, this training falls somewhere between the two extremes represented by United States and British practice. In the former the student is trained in a university school of sanitary engineering, whereas in Great Britain the sanitary engineer is a man who is first trained in civil engineering and then specializes in the field of sanitation or public health. It may be mentioned, however, that in addition to a sanitary engineer thus defined, there are in Great Britain many men working in the field of sanitation whose basic training was in chemistry or biology and who are usually members of the Royal Sanitary Institute or the Institute of Sewage Purification, or who are professional associates of the Institution of Water Engineers. In this matter of training, there is probably no one best way, and the method found most efficient for any particular country will depend on the complexity and importance of the problems to be solved.

There was general agreement at the seminar that the ultimate formation of an international association of sanitary engineers is desirable. Here it may be recalled that a somewhat similar body—the International Water Supply Association, formed in 1947—is flourishing strongly and is holding its second congress in Paris this year. Some of the problems which would be encountered in introducing any standardization in sanitary matters in Europe were apparent in the discussion of a paper by Prof. U. A. Corti, of Switzerland, on the possible development of international standards for drinking water. Until recently there was general agreement on the more obvious standards required in a potable water—the absence, for example, of toxic metals and of pathogenic bacteria. It is clear, however, that if an attempt were made at present to lay down precise standards for all the minor constituents found in natural waters, or added during the course of treatment, a wide difference of opinion would be revealed. This is obvious, indeed, from the discussions which have followed recent proposals to add fluoride to water to reduce the incidence of dental decay. In any proposal to develop international standards the first step would seem to be to introduce standard methods of chemical analysis and bacteriological examination, and this point was made by several speakers during the discussion.

An important part of the Seminar was given up to discussions on the treatment and disposal of sewage, particularly from single houses and small communities. Installations of this kind, consisting usually of a septic tank and percolating filter, are in common use in some parts of the Continent and, to a small extent, in rural districts in Great Britain. Although they are one of the earliest types of treatment plant, surprisingly little is known about the principles on which their operation depends. This applies also to the disposal of the final effluent—which may contain pathogenic organisms—by subsurface irrigation, and much more work on this subject is required. It may be mentioned, for example, that in some parts of Great Britain lack of knowledge of the movement of liquids underground, and of the removal of bacteria from them in passing through various formations, limits the disposal of household refuse by controlled tipping in abandoned gravel pits—a method which has the advantage of being the cheapest form of disposal and of reclaiming otherwise derelict land.

The seminar concluded with a very well-documented paper by Prof. M. Petrick, of Yugoslavia, on the utilization of night-soil and sewage sludge in agriculture, a subject on which there is now a considerable amount of quantitative information. There was general agreement that the series of seminars for European sanitary engineers should be continued, and it has since been announced that the third will be held in Great Britain in October this year.

BIOLOGICAL ASSESSMENT OF CHEMOTHERAPEUTICS

THE Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists held its summer meeting in Nottingham during June 12–13, at the invitation of the directors of Boots Pure Drug Co., Ltd.

On June 12, the members of the Group visited the Pharmacology and Bacteriology Divisions of the Research Department, and the Bio-Assay Division of the Standards Department. In the Pharmacology Division demonstrations were given of the methods used for examining new substances for chemotherapeutic activity against the organisms of some tropical diseases, including amœbiasis, leishmaniasis, schistosomiasis and trypanosomiasis. Particularly interesting was the exhibit showing all stages of the life-cycle of *Schistosoma mansoni*, including ova, miracidia, cercariæ and adult worms. A demonstration was given of the value of the phase-contrast microscope for the examination of living, unstained Protozoa.

A cartesian diver apparatus was shown in use to measure the rates of oxygen uptake of small numbers of *Trypanosoma congolense* under various conditions. The apparatus was based on that first described by Linderstrøm-Lang: it has been adapted for use at 37° C., and to allow addition of substrates and inhibitors to the respiring organisms.

The examination of compounds for anti-tumour activity was demonstrated. Transplanted tumours such as the Walker carcinoma in rats and the mouse sarcoma 37 were shown, and the effect of the administration of such substances as nitrogen mustard and triethylene melamine on their development.

Methods of assessment of pharmacodynamic activity in new compounds which were shown included the estimation of local anæsthetic activity by a modification of the Bulbring–Wajda method, and the estimation of antihistamine and bronchodilator activities by the inhibition of bronchoconstriction produced in guinea pigs by the intravenous injection of histamine and other bronchoconstrictor agents. A demonstration was given of a possible method of assessing cortisone-like activity by the inhibition of granuloma-formation around implanted cotton-wool pellets and other foreign bodies in the rat.

Methods for examining acute and chronic systemic toxicity were demonstrated: a simple device was shown for dispensing drug-containing diet to mice in such a way that the daily consumption can be accurately measured. Several methods of assessing local toxicity and tissue damage were shown, including intradermal injection in guinea pigs, prolonged surface application to the shaved abdomen of mice under a fluid-tight cap, and the use of a small glass vacuum-

cup to extract histamine-containing tissue fluid through the skin of a rat immediately over the site of a subcutaneous injection of an irritant substance.

In the Bacteriology Division, demonstrations were given of the various techniques used in the screening of new substances for possible activity against bacteria, viruses, and pathogenic fungi. In the Tuberculosis Section, the animal room was shown in which infected animals are maintained behind glass in a continuous current of air drawn into the room and expelled through filters. Laboratory demonstrations showed *in vitro* tests by the floating pellicle technique, and *in vivo* tests using guinea pigs and intracerebrally infected mice, and the method of assessment of drug activity on the basis of gross pathology. Groups of lungs taken from tuberculous mice, treated with known drugs such as *p*-aminosalicylic acid, thiacetazone, streptomycin, isonicotinic acid hydrazide, etc., were shown.

In the Virus Section, the use of bacteriophage as a screening virus was demonstrated. Methods with embryonated eggs for screening against influenza *A* and other viruses were shown, and with chicks against the Rous sarcoma virus. In the General Chemotherapy Section, a demonstration was given of an *in vivo* test in mice for the assessment of delay activity in penicillin preparations.

The Antibiotic Section showed the types of small-scale fermenters used for the experimental study of antibiotic production by new mutants of *Penicillium chrysogenum* or by newly isolated organisms. These included revolving tubes, shaker flasks, and larger fermenters. Methods of isolation and study of new organisms were displayed, as also were the biochemical studies carried out on the cultures during fermentations.

In the Bio-Assay Division, demonstrations included the assay of routine batches of insulin using the mouse convulsion method, and the determination of the delay activity exhibited by protamine zinc insulin in rabbits. The use of thermocouples for the determination of the rectal temperature of rabbits in pyrogen tests was shown. Other exhibits included the sulphated ox blood method of heparin assay, the rat 'line test' technique for the estimation of vitamin D and the standardization of posterior pituitary extract using the isolated uterus of the guinea pig.

On June 13 the Group visited the Veterinary Science Division at Thurgarton Priory. Demonstrations were given of the symptomatology and pathology of blackhead infection in turkeys, and methods of producing infection artificially were discussed: the use of artificially infected poults for drug assessment was described. Methods employed for the evaluation of new drugs against the common helminth parasites of domestic animals included a simple *in vivo* screening method using the free-living nematode *Turbatrix aceti*, cultured in serial dilutions of the drug.

A demonstration of work on Johnes disease in cattle included pathological specimens showing massive infection of the tissues. A brief account of the naturally occurring disease was given, and attempts at treatment with streptomycin and thiacetazone were described. A biochemical study of the digestive metabolism of ruminants was discussed. The changes which occur in the leucocyte picture and in certain blood constituents of the ewe in late pregnancy were described, and their possible relation to the adrenocortical hormones was discussed. An account was given of a method of field evaluation of sheep dips, in which an attractant solution is applied to the skin and wool of sheep at intervals after dipping, and the efficiency determined by the effect on blowflies attempting to oviposit on the wool.

Demonstrations were given of the methods used in the evaluation of disinfectants for dairy use. Disinfectants for hatching eggs were tested on eggs infected on the surface with a *Salmonella* culture. Disinfectants for dairy utensils were assessed by their effect on plate counts on standard metal strips infected with cultures suspended in milk. Field trials of dairy disinfectants under working conditions were described.

The meeting ended with a short scientific session at which papers by Dr. G. F. Somers on "The Assay of Adrenaline in Creams", and by Dr. P. W. Muggleton on "The Standardization of Pertussis Vaccine" were read and discussed. The chairman of the Group, Dr. H. O. J. Collier, expressed the appreciation of the members to Mr. W. A. Broom and his colleagues for organizing the meeting.

TRANSPARENT CONDUCTING FILMS OF GOLD

In an article in *Nature* describing recent work in the Light Division of the National Physical Laboratory, Teddington, on methods of producing transparent electrically conducting films on glass[1], the films then mentioned were oxide films; and, although the conductivity of some, especially tin oxide, had been abnormally enhanced by special treatment, the *modus operandi* is not yet fully understood. One object of the work was to provide means for heating the glass electrically; but it was noted that the resistance of the films was rather high, making necessary the use of voltages of some hundreds for the effective de-icing of coated aircraft windows in adverse conditions.

A further investigation has rapidly followed this, by the same workers, and with the same practical aim. The results are noteworthy because they touch upon a rather different field of research. It has long been known that metallic films, made by no matter what process, almost always have a much greater resistivity than the bulk metal, even after allowance for an expected increase due to the thinness of the films. This discrepancy between observed and predicted resistivities is assignable to the difference between the granular or non-coherent structure of the actual films, and the homogeneous plane-parallel model assumed in the theory.

The starting-point of the new investigation was a study of the influence which the condition and material of the substrate might have upon the properties of superposed gold films. For example, a gold film laid down on glass cleaned with dry precipitated chalk was found to have a resistivity less than half that of similar films on glass cleaned by more ordinary methods, while the colour of the film was a dull yellowish-green instead of the familiar bluish-green. These experiments were made with gold films about 70 A. in thickness, laid down under strictly controlled conditions by cathodic sputtering. Similar films were then laid down on glass freshly coated with substrate films of various oxides, also made by sputtering. In some such cases, especially with substrates of the oxides of cadmium, lead, bismuth and zinc, the properties of the gold film were even

more strongly modified. Films on zinc oxide were always blue, with almost infinite resistance. Films 70 A. in thickness (on a weight–bulk density basis) on bismuth oxide were, however, of a pale-straw colour, and had a resistance of about 15 ohms between opposite edges of a square sample. The transmission factor for white light was about 70 per cent. On heating such a sample to 200° C. for a few minutes the colour became paler still, the transmission factor rose to about 73 per cent, and the resistance dropped to about 10 ohms. Moreover, these results were very closely reproducible from sample to sample. For comparison, it is to be noted that a similar film on glass cleaned by ordinary methods would be blue-green in colour, and have a transmission of about 65 per cent and resistance of unpredictable value in a range of roughly 80–200 ohms.

It is further of interest to note that, with these films of gold on a substrate of oxide, the transmission can be further enhanced by using various methods analogous to 'blooming'.

For the moment, the structure of the highly conducting films is a matter of speculation but is being immediately investigated. It is, however, remarkable that the resistance value obtained is very close to the theoretical value for a plane-parallel lamina having the same weight of gold per unit area as the actual film. It seems also that the low optical absorption may be consistent with the optical constants for gold in bulk, with some form of 'thinness' correction, though this has not yet been fully investigated.

Whatever film-structure may be revealed by further examination, this work appears to offer an interesting new field for the study of surface forces and states, as well as providing for practical applications a transparent film of a novel type and exceptionally low resistance. It is understood that the Ministry of Supply, for which the research is being undertaken by the National Physical Laboratory, is actively engaged in studying the problems of producing and using windows having a coating of this double-layer film.

[1] *Nature*, **169**, 829 (1952).

HOMING ABILITY IN BIRDS

A RECENT issue of *Ibis* contains two important articles on the direction-finding abilities of birds (**94**, No. 2).

In the first article G. V. T. Matthews describes an extensive series of homing experiments carried out with 249 lesser black-backed gulls (migratory species) and 91 herring gulls (a restricted nomad), together with twenty other sea birds. On release the lesser black-backed gulls showed a significant homeward orientation which was absent when the sun was obscured by clouds; some direct evidence and an analysis of the homing success indicated that a large proportion of the gulls were homing by an inefficient method, probably random exploration for known visual landmarks. A minority, however, were homing by a method not dependent on the distance or area of release, the orientation behaviour suggesting some form of sun navigation. The herring gulls showed a much lesser ability to 'home', and this could be explained by there being a much smaller proportion of able navigators among them. Matthews also carried out experiments in which the earth's magnetic field was masked by airborne magnets; this in no way affected homing ability.

In the second article Gustav Kramer describes experiments carried out with starlings and homing pigeons. The starling's ability to reproduce constant compass directions was demonstrated in two ways: first, by using migratory activity as an indicator, the bird tending to take up a constant direction; second, by training the birds to choose one of several (up to twelve) feeders symmetrically distributed around the cage. If the incidence of light were changed by use of a mirror arrangement the direction chosen by the bird changed correspondingly. The sun was shown to be a governing factor, the orientation faculty (in experimental conditions) vanishing if the sun were hidden. The correct direction was reproduced regardless of the time of day.

Experiments with homing pigeons showed that these birds were able to home over an unknown stretch of two hundred miles. Some sort of astronomical navigation is suggested by the fact that the pigeons seemed to be orientated even before starting. Apart from this orientation method direction, learning could be produced by training the pigeons along one homing line; by displacing the bird sideways they are misled, this being taken as the test of direction learning.

Like starlings, pigeons were trained to choose food from a definite direction under experimental conditions, and here again the sun was the physical clue for orientation.

BRITISH COAL UTILIZATION RESEARCH ASSOCIATION

REPORT FOR 1951

WITH an annual fuel crisis tending to become an accepted feature of British life, means of increasing the output of coal from all indigenous sources have been widely publicized and implemented, so that coal production has been rising steadily during recent years. The nation's fuel problem remains, however, for coal consumption has also increased, so that now a gap exists between demand and supply which will doubtless widen unless and until coal is used more wisely and far more efficiently than at present. It is gratifying to note, therefore, that the resources of the British Coal Utilization Research Association are being devoted to bringing "in our time" a real improvement in the efficiency of using coal in all its conditions of availability.

Progress towards that aim is described in the annual report of the Association*, which was presented by the president, Sir Charles Ellis, to the annual general meeting on May 7. The many investigations being pursued include a new method of conditioning slurry, the automatic control of coal-fired gas producers, the reduction of smoke from domestic open fires, and the use of coal for chemical purposes.

Several million tons of wet coal slurry are produced each year in colliery washeries. As produced, the slurry is a water-logged aggregate which, even after dewatering, is too finely divided to burn satisfactorily. If it could be converted into a usable form, however, this material would make a substantial contribution to the nation's fuel supplies. A pelleting process has

* British Coal Utilization Research Association: Annual Report for 1951. Pp. 52. (Leatherhead: the Association, 1952.)

now been devised in which the slurry, pre-treated to form a wet mud, is first broken up and then agglomerated into spherical particles of either ⅛–¼ in. or ¼–½ in. diameter. The pelleting device is simple; the pellets themselves, when dried, are strong enough to withstand moderate handling, and have been burnt successfully on a mechanical stoker plant and do not disintegrate in the fuel bed of a gas producer.

The work on the automatic control of gas producers is aimed at improving practice in respect of the coal-fired producer so that coal may compete more favourably with imported oil as a fuel for the steel and glass industries. Two systems of control of the coal feed to gas producers have now been developed which maintain, under conditions of variable load, a constant quality of the gas. In one, which is recommended for use in steelworks, the rate of coal feed is linked directly to the rate of air feed to the producer. In the other, which is simpler, the controller is operated by the gas off-take temperature, and is to be preferred for use in the glass industry. A recent development of the former system is the use of blast steam pressure as the main controlling variable instead of air flow.

The ever-present problem of smoke emission is being studied in four different ways, namely: an investigation of the factors affecting the release of smoke from burning coal; the destruction of tar vapours in smoke; the possibility of reducing smoke formation by chemical pre-treatment of coal; and reduction of smoke by modified appliance design. Work on the first three problems is still in its early stages. Modifications to the design of domestic open fires have led to reduced smoke emission, but only under such rigid control as cannot yet be obtained under normal home conditions.

Although the work of the Association is concerned primarily and inevitably with the use of coal as a fuel, the possibility of coal replacing oil as a source of essential chemical substances in the future has not been overlooked, and a first method of attack by solvent treatment is being made.

The work of the Association as a whole must be regarded as of great value to a country the economy of which is based on coal, and it is to be hoped that circumstances will permit of its future expansion and acceleration.

WILD LIFE IN ARABIA

OPEN plains, scorching and shadeless during the summer, windswept and freezing during the winter night, present a hard environment. Yet up to the beginning of the present century an interesting assemblage of animals existed in the Arabian desert. Even when modern rifles came into general use the species held their own to a satisfactory extent. But the last decade has witnessed the advent of a mechanized predator, the 'jeep', and, according to a recent article by Desmond Foster-Vesey-Fitzgerald, it cannot be long before motorized hunting parties will sweep Arabia's fauna away (*Oryx*, **1**, No. 5; April 1952).

It may be of value, therefore, to record the status of some of the more interesting animals during recent years. The Arabian oryx is now extinct in the northern sands of the Great Nafud. Some interesting pictures of this species have been scratched by idle shepherds on sandstone outcrops in the vicinity of Hail. In the southern sands of the Rub Al Khali the oryx still exists.

Three species of gazelle are still widespread and reasonably numerous. The northernmost species is Loder's gazelle, the 'rhim' or the Arab (*Gazella leptoceros marica*), which inhabits the gravel plains, limestone plateaux and sands of Central Arabia. This is a gazelle of the steppe where perennial dwarf shrubs are supplemented by abundant annual herbage following winter rains. It is a stocky, whitish animal which congregates in large flocks composed of fifty to a hundred individuals. It has not been observed to leap or bound like the other species, but travels nevertheless at a deceptively fast speed. The 'rhim' is the only species found on the northern gravel plains and along the fringes of the central Arabian sands, being especially abundant on the Bisaita plain and Teisiya plateau. It extends southwards into the tropic, where it has been observed congregating with the other species.

The other two species, the dorcas gazelle (*Gazella dorcas saudiya*) and the Arabian gazelle (*Gazella gazella arabica*) are both graceful reddish animals which leap and bound in a manner quite unlike the 'rhim'.

The dorcas gazelle or 'afri' appears to be confined to those parts of the interior of the peninsula where *Acacia* grows. It ranges widely over the great gravel plains which lie to the east of the Hejaz mountains but is only encountered in very small parties or alone.

The Arabian gazelle or 'idmi' is also a gazelle of *Acacia* country and appears to be the common species of the coastal plains. But it also occurs on the highland plains of the interior with the dorcas gazelle and is, in fact, the commonest species in all the country to the east of Taif.

Gazelle in Arabia never drink and they are able to exist without green herbage or dew. It must be presumed that the necessary moisture for their welfare is obtained from buds of perennial plants which, although encased within dry scales during drought periods, remain viable and ready to burst as soon as rains fall. Probably the most important plant in this category for the 'rhim' is the dwarf shrub *Rhanterium eppaposum*, and for the other species the various kinds of *Acacia*.

The ibex exists in Arabia where a suitable habitat occurs. Such places include the sandstone gorges around Medain Saleh in the Hejaz, the basalt ranges of the Jebel Shammar around Hail, and the drier mountains of Dhofar in Southern Arabia.

The wolf (*Canis lupus* var.) is still fairly common in Central Arabia, especially in the limestone country where springs are frequent and caverns provide suitable dens. The striped hyena is widespread but nowhere common, although tracks are often seen on the Red Sea coastal plains.

The leopard is rare but exists in the Red Sea hills south of Jedda, where baboons are plentiful, and also in the more generously wooded hills of Dhofar.

In Arabia the ostrich is extinct, although it would appear that these birds existed in some numbers over the open gravel plains of the Bisaita in North-Western Saudi Arabia until about twenty years ago. During the 1930's there was a big massacre in order to obtain plumes; but a few survivors lingered on until about 1944, when the last were killed. In south-eastern Arabia the ostrich became extinct about sixty years ago; but fragments of egg-shell can still be quite frequently found in the Bainuna country between the base of the Qatar peninsula and the Trucial coast.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Detection of Radiophosphorus in Cells and Spores of Fungi by Radioautography

THE employment of radioautographic techniques has been of much value in botanical studies in demonstrating the presence and localization of tracer elements within plant organs and tissue. In this respect the work of Arnon *et al.*[1], Colwell[2], and Harrison *et al.*[3], may be cited as typical. Pearson *et al.*[4] prepared radioautographs of fungus cultures, but stated that because of the limitations of the materials and methods employed it was not possible to obtain radioautographs of single cells or hyphæ. Boyd *et al.*[5], however, were able to obtain single cell autographs of leucocytes and erythrocytes. More recently, Fitzgerald *et al.*[6], using tritium, obtained radioautographs of single yeast cells and *Paramecia*.

In the method employed here, phosphorus-32 was added to the nutrient medium in the form potassium dihydrogen phosphate. *Aspergillus* sp., *Hormodendrum* sp. and *Penicillium* sp. were grown on nutrient agar ('Difco') containing 5 per cent glucose. *Saccharomyces cerevisiæ* was grown in nutrient broth ('Difco') containing 5 per cent glucose. Cells harvested from these media were washed and placed directly upon the surface of a photographic emulsion. Best results were obtained with a special emulsion (*NTB* plates) developed by the Eastman Kodak Research Laboratories, Rochester, N.Y. After exposure, the plates were developed in a 'fine grain' developer.

The accompanying photographs are from representative radioautographs obtained in this work. It seems of interest to note that localization of activity occurred not only in mycelium but also among conidia from the same test-tube culture, some producing radioautographs and others not. Perhaps conidia of different ages vary in their phosphorus content. A like condition was noted among cells of *S. cerevisiæ* from a single broth culture. This is in agreement with the results of Boyd and Levi[7], who reported finding evidence of non-uniform uptake of phosphorus-32 by yeast cells.

This work was conducted in the Department of Botany, McMaster University, Hamilton, Ontario.

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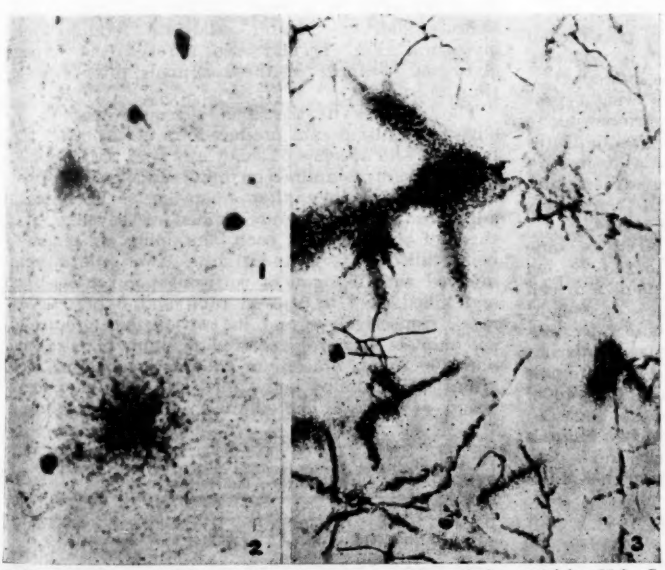
[1] Arnon, D. I., Stout, P. R., and Sipos, F., *Amer. J. Bot.*, **27**, 791 (1940).
[2] Colwell, R. N., *Amer. J. Bot.*, **29**, 798 (1942).
[3] Harrison, B. F., Thomas, M. D., and Hill, G. R., *Plant Physiol.*, **19**, 245 (1944).
[4] Pearson, I. A., Hammer, J. M., Corrigan, K. E., and Hayden, H. S., *J. Bact.*, **56**, 397 (1948).
[5] Boyd, G. A., Casarett, G. W., Altman, K. I., Noonan, T. R., and Salomon, K., *Science*, **108**, 529 (1948).
[6] Fitzgerald, P. J., Eidinoff, M. L., Knoll, J. E., and Simmel, E. B., *Science*, **114**, 494 (1951).
[7] Boyd, G. A., and Levi, H., *Science*, **111**, 58 (1950).



Radioautographs of: (1) *S. cerevisiæ* cells grown in nutrient solution containing 36·5 μC. phosphorus-32. (× 540.) (2) *Aspergillus* sp. conidia from nutrient agar containing 13·8 μC. phosphorus-32. Exposure period, 14 days on Kodak *NTB* emulsion. (× 540.) (3) *Penicillium* sp. mycelium from a nutrient solution containing 250·0 μC. phosphorus-32. Exposure period, 30 days on Kodak *NTB* emulsion. (× 120)

Effect of Œstradiol Benzoate and Orchidectomy on the Toxicity of Trypan Blue

PRISELKOV[1] found that the toxic effect of trypan blue was manifested in guinea pigs by loss of weight and hair, apathetic appearance, fall in hæmoglobin content, accumulation in the blood of large numbers of polychromatophiles and normoblasts and the appearance of erythrocyte decomposition products in many organs. Nicol[2] pointed out that some animals appeared to be more susceptible to the toxicity of the dye during œstrus. The toxic effect of injections of trypan blue on the tissues has been studied histologically by Downey[3], who observed that the cells of connective tissue first showed diffuse staining of the cytoplasm and the nucleus which he considered to be the appearance of dying cells. Many cells died, but some were able to eliminate the dye and recover, except the eosinophiles. The reticulo-endothelial cells, which specifically store the vital dye, are affected in the same manner, and it is probable that the resulting inhibition of the functional capacity of the reticulo-endothelial system is partly responsible for the toxic manifestations of trypan blue.

In view of the stimulating effect of œstrogens on the reticulo-endothelial system[2,4], it was considered desirable to ascertain their influence on the toxicity of trypan blue.

In the present experiments, the toxicity of trypan blue, judged

by the mortality-rate and by the effect on body-weight, was studied in ninety guinea pigs, all of which received one daily subcutaneous injection of trypan blue for six days. The daily dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. The animals were weighed immediately before the first and after the last injection of trypan blue. They were divided into three groups : 30 intact males, 24 orchidectomized animals and 36 ovariectomized animals. Each group included animals which received only the dye injections and therefore served as controls, and also animals which received one daily intramuscular injection of 0·5 mgm. œstradiol benzoate for one to four weeks, during the last six days of which they also received the dye. Œstradiol benzoate was selected for the present investigations because of its low toxicity compared with other œstrogens[5].

Results in intact male animals. Trypan blue was responsible for the death of one out of seven animals not given hormone, and one out of twenty-three animals treated with hormone. The changes of weight observed after the course of trypan blue injections averaged a loss of 6·5 per cent in seven animals not given hormone, a loss of 6·2 per cent in six animals given œstradiol benzoate for one week, a loss of 0·9 per cent in six animals given œstradiol benzoate for two weeks, a gain of 1·9 per cent in five animals given œstradiol benzoate for three weeks and a loss of 1·3 per cent in six animals given œstradiol benzoate for four weeks.

To ascertain to what extent these changes of weight were due to the trypan blue, five intact animals were given one daily intramuscular injection of 0·5 mgm. œstradiol benzoate for four weeks and were not given trypan blue. They were weighed regularly at weekly intervals. No animals died as a result of the hormone treatment. The average weekly change in body-weight in these animals was a gain of 2·4 per cent during the first week, a gain of 1·8 per cent during the second week, a gain of 1·9 per cent during the third week and a gain of 0·8 per cent during the fourth week. The gain in weight is probably due to the water-retaining power of the œstrogen[6].

Comparison between the changes of weight produced by trypan blue alone, by the hormone alone and by the hormone together with the dye indicates that the œstrogen conferred a certain degree of immunity against the toxicity of the trypan blue, and that this immunity was most marked in the animals which received the œstrogen for three weeks.

Results in orchidectomized animals. Trypan blue was responsible for the death of one out of ten animals not given hormone and two out of fourteen treated with hormone. The changes of weight observed after the course of trypan blue injections averaged a loss of 5·6 per cent in ten animals not given hormone, a loss of 1·3 per cent in four animals given œstradiol benzoate for one week, a gain of 2·3 per cent in three animals given œstradiol benzoate for two weeks, a gain of 6·4 per cent in two animals given œstradiol benzoate for three weeks and a gain of 5·1 per cent in five animals given œstradiol benzoate for four weeks.

Comparison between the above changes of weight in the orchidectomized animals and those in the intact animals shows that the toxic effect of trypan blue was less in the orchidectomized than in the intact animals, and indicates that orchidectomy adds to the protective influence of the œstrogen.

Results in ovariectomized animals. Trypan blue was responsible for the death of two out of twelve animals not given hormone, and four out of twenty-four treated with hormone.

The changes of weight observed after the course of trypan blue injections averaged a loss of 5·9 per cent in twelve animals not given hormone, and a loss of 3·5 per cent in twelve animals given œstradiol benzoate for one week, while in twelve animals given œstradiol benzoate for two weeks practically no change in weight occurred. The results, therefore, show that œstradiol benzoate reduced the loss in weight produced by the toxic effect of the dye.

The protective influence of œstradiol benzoate against the toxicity of trypan blue, observed in all the groups of animals, may be attributed to its stimulating effect on the reticulo-endothelial system, which thus becomes more capable of dealing with the dye and detoxicating it. The effect of orchidectomy may be explained by a similar stimulating influence on the reticulo-endothelial system.

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[1] Priselkov, M. M., *J. Biol. Med. Exp. U.S.S.R.*, **13**, 5 (1929).
[2] Nicol, T., *Trans. Roy. Soc. Edin.*, **58**, Pt. 2, No. 19 (1935).
[3] Downey, H., *Anat. Rec.*, **15**, 103 (1918).
[4] Nicol, T., and Helmy, I. D., *Nature*, **167**, 199 (1951).
[5] Nicol, T., and Helmy, I. D., *Nature*, **167**, 321 (1951).
[6] Thorn, G. W., Nelson, K. R., and Thorn, D. W., *Endocrin.*, **22**, 155 (1938).

Antagonistic Effects of Cortisone and Salicylate

The injection of cortisone has been observed to cause glycosuria in normal rats fed on a high carbohydrate diet[1]. Sodium salicylate reduced this glycosuria (Fig. 1) and also reduced the hyperglycæmia obtained in these animals after feeding (Fig. 2).

The changes in the liver glycogen content of adrenalectomized rats produced by cortisone in the presence and absence of salicylate were also studied. The rats were maintained on 0·5 *N* saline and a normal diet for four days after operation. Forty-eight adrenalectomized rats were divided into seven groups, three of these groups, each containing six animals, being killed at 0, 4 and 6 hr.; two groups were injected with 5 mgm. of cortisone per rat at 0 hr. and killed at 4 hr. (seven rats) and 6 hr. (eleven rats), respectively; and in two further groups of six animals each rat received 5 mgm. of cortisone and 100 mgm. of sodium salicylate at 0 hr., one group being killed at 4 hr. and the remaining group at 6 hr. The animals were fasted during

Time of sacrifice (hr.)	Liver glycogen content (gm./100 gm. wet wt.) with standard deviations					
	Untreated	No. of rats	Treated with cortisone	No. of rats	Treated with cortisone/salicylate	No. of rats
0	2·33±0·55	6				
4	1·77±0·81	6	3·30±2·90	7	0·50±0·12	6
6	1·45±0·7	6	3·91±1·99	11	0·60±0·2	6

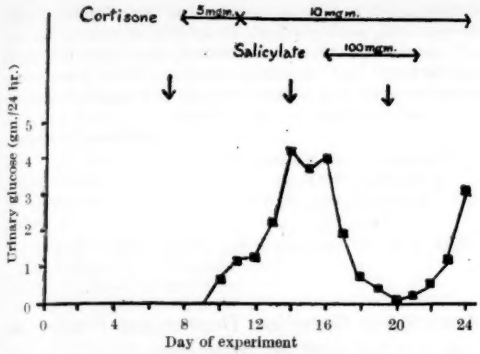

Fig. 1. Mean 24-hr. urinary glucose for a group of four normal rats fed on a high carbohydrate diet and injected with cortisone and sodium salicylate. Cortisone: 5 or 10 mgm. as saline suspension of cortone acetate (Merck) daily; sodium salicylate: 100 mgm. in 1 ml. arachis oil daily. The arrows indicate the days on which the blood sugar curves in Fig. 2 were obtained

the experiment. The glycogen content of liver was estimated by the method of Good, Kramer and Somogyi[2], and the results are shown in the accompanying table.

Comparison of these results showed that salicylate, in the presence of cortisone, caused significant depletions of liver glycogen at 6 hr. compared with both the group treated with cortisone ($P = 0{\cdot}01$) and the untreated group ($P = 0{\cdot}01$). Cortisone produced a significant deposition of liver glycogen at 6 hr. ($P = 0{\cdot}1$) when compared with the initial value at 0 hr. Salicylate therefore not only caused breakdown of existing glycogen but also prevented the formation of new glycogen by cortisone.

These antagonistic effects of salicylate and cortisone are of interest for two reasons. First, it has been suggested that the therapeutic activity of salicylates is mediated by the pituitary and adrenal cortex, leading to the production of adrenal corticoids[3]. If this hypothesis is correct, then salicylates and adrenal corticoids, of which cortisone may be considered a typical example, should have the same general effects in the tissues. Secondly, salicylates have been observed to reduce the glycosuria and blood glucose of alloxan-diabetic rats[4]; in these animals there is increased gluconeogenesis due to the action of adrenal corticoids, and an inhibition of this process by salicylates may provide at least a partial explanation of these effects.

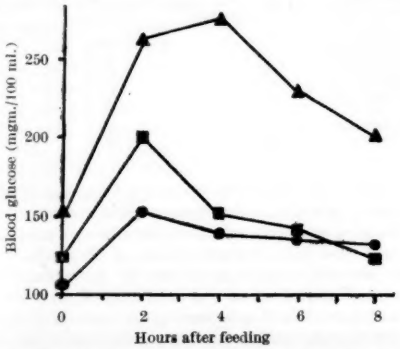

Fig. 2. Mean blood sugar curves after feeding the rats described in Fig. 1. The animals were fasted for 16 hr. before being given the same amounts of the high-carbohydrate diet by stomach tube. ●, control period; day 7, Fig. 1; ▲, cortisone period; day 14, Fig. 1; ■, cortisone/salicylate period; day 19, Fig. 1

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[1] Ingle, D. J., *Endocrin.*, **29**, 649 (1941).
[2] Good, C. A., Kramer, H., and Somogyi, M., *J. Biol. Chem.*, **100**, 485 (1933).
[3] Hetzel, B. S., and Hine, D. C., *Lancet*, ii, 94 (1951).
[4] Smith, M. J. H., Meade, B. W., and Bornstein, J., *Biochem. J.*, **51**, 18 (1952).

Effect of Tissue Cultures of Maize Endosperm on the Growth of Excised Maize Embryos

In 1947, LaRue reported the regeneration of sporophytes from maize endosperm tissue, and also limited growth of the endosperm tissue without regeneration or differentiation when excised and placed on an appropriate artificial medium[1]. In 1948, continuing this study, he succeeded in obtaining a culture of maize endosperm of a callus-like nature having unlimited growth[2]. This original stock has been in culture for more than two years, and I also have stocks in culture from two other varieties of maize.

Ziebur and Brink reported in 1951 the stimulative effect of freshly excised *Hordeum* endosperms on the growth of immature plant embryos *in vitro*[3]. It was thought of interest to study the effect of cultured endosperm tissue on the growth of freshly excised maize embryos of various ages to observe whether or not it would still function as a nutrient endosperm for the embryos[4]. A preliminary experiment has therefore been carried out at the University of Michigan.

The cultured maize endosperm tissue employed in this experiment was that of LaRue's original stock. This tissue has been found to grow well only on a basal medium supplied with certain additional substances. White's basic medium plus tomato juice has been used for obtaining good growth.

The embryos were placed directly upon (1) White's basic medium, (2) White's plus tomato juice, and on masses of maize endosperm tissue from culture which had been transferred previously to (3) White's and (4) White's plus tomato juice. Embryos were also placed on masses of crown gall tumour tissue growing on (5) White's and (6) White's plus tomato juice medium. The results, recorded after five days, are given in the accompanying table. Growth is indicated by the plus signs and no growth by the minus signs.

Medium	16-day embryo var. 'Our Choice' 0·5–1·0 mm. length	20-day embryo var. 'Surprise' 3·0–4·0 mm. length
1	+	+ + + + +
2	+	+ + +
3	—	+ + +
4	—	+ +
5	—	+
6	—	+

1. Endosperm cultured on White's medium + tomato juice.
2. " " " " " "
3. White's medium + tomato juice.
4. " " " " " "
5. Crown gall tissue growing on White's medium + tomato juice.
6. " " " " " " "

It is apparent from these results that the endosperm tissue in culture does improve the growth of the excised embryos. The growth of the older embryos is better than on the nutrient medium alone. It stimulates some growth of the younger embryos. Crown gall tissue does not improve growth of the embryos. It is noted that the addition of tomato juice improves the growth of the embryos on the basal medium. It may be concluded that the cultured endosperm has retained its endosperm function.

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[1] LaRue, C. D., *Amer. J. Bot.*, **34**, 585 (1947).
[2] LaRue, C. D., *Amer. J. Bot.*, **36**, 10 (1949).
[3] Ziebur, N. K., and Brink, R. A., *Amer. J. Bot.*, **38**, 253 (1951).
[4] LaRue, C. D., *Bull. Torrey Club*, **63**, 365 (1936).

A New Technique for the Sterile Culture of Plant Embryos *in vitro*

The two essentials for successful tissue culture are a sufficient supply of nutrients and adequate aeration. In the culture of plant embryos from an early stage of development it is also often desirable that cultures shall be suitable for microscopical examination.

The relative merits of different culture containers are discussed by White[1], and the technique here described combines the simplicity and freedom of manipulation of the flask method with ease of microscopical examination afforded by the hanging drop.

The embryos are grown on two strips of filter paper (No. 1. 4 × 1 in.) supported on a glass strip (3 × ¾ in.). This is placed in a boiling tube (6 × 1 in. 'Pyrex') containing 5 c.c. of liquid medium so that it rests nearly vertically with one end in the medium. The tubes are afterwards plugged with cotton-wool and sterilized ready for inoculation. The medium is absorbed by the filter paper and is readily available to the embryos, which are thus surrounded by a film of nutrients and also have free access to the air. If, however, the dimensions of the filter paper do not exceed those of the slide, the medium is less accessible to the embryos.

Embryos placed centrally on the slide can be examined in detail during all stages of development through a microscope with a 1-in. objective without their being removed from the tube. Tubes can be placed horizontally, or nearly so, without spilling or wetting of the cotton-wool plugs by the medium; the dimensions are such that the liquid runs down beneath the slide, and with care there is little danger of the embryos being washed out of position. Measurements can therefore be made with an eyepiece micrometer and camera lucida. In later stages of development the seedling grows in an upright position and can be measured against a scale on the filter paper or a ruler with reasonable accuracy.

Cultures are economical and easy to maintain over long periods of time. Evaporation from the tubes is low, and it has been found that a change of medium once a fortnight is satisfactory. This can be done by removing the embryos singly with forceps into a new tube, or by transferring the whole slide from one tube to another with no disturbance to the embryos.

Large numbers of samples can be maintained at any one time in a small space since tubes are easy to store, and in the early stages of development five, or even ten, embryos can be grown in one tube.

It is possible that this method may prove equally satisfactory for culturing tissues other than plant embryos, where a liquid medium is required without the disadvantages of immersion.

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[1] White, P. R., "A Handbook of Plant Tissue Culture" (1943).

Autonomic Ganglion Depressant Properties of Barbiturates

Though the central nervous system depressant and anticonvulsant properties of the many derivatives of barbituric acid have been extensively studied, relatively little is known of their effects on the autonomic nervous system.

Depressant effects of amylobarbitone on the cardiac vagus were first described by Lieb and Mulinos[1], and have been confirmed by other workers. Depressant effects on salivary secretion were shown by Stavraky[2], for amylobarbitone, and by Emmelin[3], for hexobarbitone. It is not clear from any of this work whether the depressant effects were exercised at the autonomic ganglion or more peripherally.

Initial experiments showed that amylobarbitone sodium, administered intravenously to the cat in doses of the order of 5 mgm. per kgm., depressed ganglionic transmission without depressing the peripheral structures. By a method involving periodical electrical stimulation of the pre-ganglionic trunk of the cervical sympathetic, and recording of the contractions of the nictitating membrane, ganglion depressant effects of amylobarbitone were compared quantitatively with those of tetraethylammonium iodide; amylobarbitone was about one-quarter as potent as tetraethylammonium iodide. In a similar manner, the depressant properties of some fifteen of the commoner barbiturates were compared with those of amylobarbitone. The accompanying table shows the results obtained with a few of the more interesting derivatives.

Barbiturate (as sodium salt)	(*A*) Mean potency on sup. cerv. gang. ± stand. errors	(*B*) Relative anæsth. potency	Ratio $\frac{A}{B}$
Amylobarbitone	100·0	100·0	1·00
Butobarbitone	99·1 ± 6·2	71·0	1·40
n-Hexylethyl	43·4 ± 2·7	69·2	0·63
Pentobarbitone	42·5 ± 1·5	163·6	0·26
Hexobarbitone	31·7 ± 2·9	186·2	0·17
Barbitone	17·1 ± 1·3	23·1	0·74
Phenobarbitone	14·2 ± 0·6	40·3	0·35
Thiopentone	12·8 ± 1·2	450·0	0·03

The first two columns show: (*A*) mean ganglion depressant potencies determined from a number of experiments, and (*B*) relative intravenous anæsthetic potencies (calculated from data of Butler[4]). The figures are expressed in terms of amylobarbitone, which has been allotted the arbitrary figure 100·0 in each instance. It is interesting to note that, for the different drugs, ganglionic and anæsthetic potencies show no direct correlation one with the other; amylobarbitone and butobarbitone show the highest activity on the ganglion and thiopentone the lowest. Pentobarbitone, which is isomeric with, and more

potent an anæsthetic than, amylobarbitone, shows an activity of only 42·5 on the ganglion. The relationship between ganglionic and central nervous depressant activities is expressed in the third column as the ratio A/B. The highest ratio (1·40) is given by butobarbitone.

Other barbiturates, which are not in current clinical use, are now being investigated with the view of determining the structure – action relationships responsible for conferring increased ganglion depressant effects.

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[1] Lieb, C. C., and Mulinos, M. G., *Proc. Soc. Exp. Biol., N.Y.*, **26**, 709 (1929).
[2] Stavraky, G. W., *J. Pharmacol.*, **43**, 499 (1931).
[3] Emmelin, N. G., *Acta Physiol. Scand.*, **2**, 289 (1941).
[4] Butler, T. C., *J. Pharmacol.*, **74**, 118 (1942).

Rigid-Body Motions in Special Relativity

The rigid-body motions proposed by Born[1] and Herglotz[2] have, in general, only three degrees of freedom, so that the world line of one point determines the complete motion. My purpose here is to define a group of rigid-body motions with six degrees of freedom as in Newtonian mechanics. Any such definition must be regarded as tentative, and its physical significance tested by experiment (see following communication from Prof. J. L. Synge).

In the space-time of Minkowski, where a point has the four co-ordinates x^1, x^2, x^3, x^4 $(= ict)$, let a world line be determined by the equations:

$$x^r = a^r + b_1\mu_1{}^r + b_2\mu_2{}^r + b_3\mu_3{}^r + b\lambda^r, \quad (r = 1, 2, 3, 4). \qquad (1)$$

Here a^1, a^2, a^3 are three arbitrary functions of a parameter u, and $a^4 = icu$; λ^r is the unit 4-vector in the direction of the da^r/du; $\mu_1{}^r$, $\mu_2{}^r$, $\mu_3{}^r$ form an orthonormal triad of 4-vectors orthogonal to λ^r, which triad may be specified by three arbitrary functions of u giving, say, its Eulerian angles; b_1, b_2, b_3 are constants and $b = (b_1{}^2 + b_2{}^2 + b_3{}^2)^{1/2}$. By letting b_1, b_2, b_3 have a range of values, we get a congruence of world lines depending on six arbitrary functions of u. If a body moves so that the world lines of all the particles form such a congruence, then we shall say that the body has a rigid motion.

The curve $x^r = a^r$ is the history of the particle for which the b's vanish; this particle, which takes a special role, may be called the 'drag-point'. Since $a^4 = icu$, the parameter u may be interpreted as the time along the world line of the drag-point.

The connexion with Newtonian rigidity and the Lorentz contraction may be seen as follows. If x^r and y^r are two events of the congruence with the same value of u, then the invariant $(x^r - y^r)(x^r - y^r)$ with r summed, which is the square of the Minkowski distance, is independent of u and therefore remains constant throughout every rigid motion. The value of $\lambda^r(x^r - y^r)$ also remains constant. This latter condition implies that whenever the body, initially at rest, is accelerated and finally moves in uniform translation, it is shortened in the direction of motion by the Fitzgerald–Lorentz contraction factor.

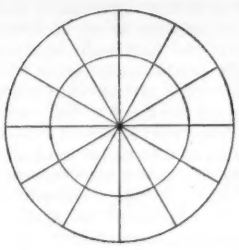

Fig. 1

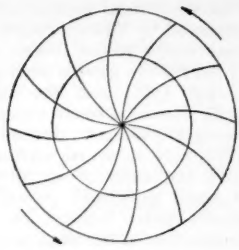

Fig. 2

The following example of rigid motion is a relativistic analogue of the Newtonian rotating disk. Choose for the drag-point the origin of a Galileian observer S so that a^1, a^2, a^3 are all zero. For the rotating triad take $\mu_1{}^r = (\cos\theta, \sin\theta, 0, 0)$, $\mu_2{}^r = (-\sin\theta, \cos\theta, 0, 0)$ and $\mu_3{}^r = (0, 0, 1, 0)$, where θ is some function of u. With b_3 equal to zero, equations (1) give the motion of all points in the x_1, x_2 plane, the first and second derivatives of $\theta(u)$ representing the angular velocity and angular acceleration of the body respectively. Fig. 1 shows the disk at rest in S with radial lines and circles about the origin etched on its surface, and Fig. 2 shows the same etchings as they appear to S when the disk has acquired a constant angular velocity ω, drawn for the case when the peripheral velocity is $\frac{1}{2}c$. The straight radial lines become curved with polar equation $r\omega = c(\theta + \text{constant})$. The radii of the circles remain the same, as indeed is true even in non-uniform angular motion.

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[1] Born, M., *Ann. Phys.*, **30**, 1 (1909).
[2] Herglotz, G., *Ann. d. Phys.*, **31**, 393 (1910).

Gardner's Hypothesis and the Michelson–Morley Experiment

When Gardner's hypothesis (see preceding communication) is applied to the Michelson–Morley experiment, performed with an interferometer with horizontal rigid arms, carried on the rotating earth, it yields the following formula for fringe-shifts if we take the drag-point to be the centre of the earth:

$$\delta/w = (D/\lambda)(E/c)\varphi \sin 2\theta.$$

Here δ is the fringe-shift, w the fringe-width, D the arm-length of the interferometer, λ the wave-length used, E the velocity of the earth's surface due to the earth's rotation alone, c the velocity of light, φ the deviation of the plumb line, and θ the azimuth of the telescope arm, from the north eastward. If, on the other hand, the drag-point is near the interferometer, the predicted fringe-shift is below the limits of observation.

In a set of experiments involving a very great number of observations, D. C. Miller[1] observed fringe-shifts resembling those predicted by the above formula, which reads, when we insert the numerical values appropriate to Miller's experiments:

$$\delta/w = 0{\cdot}23 \sin 2\theta.$$

The theoretical amplitude is about four times that observed by Miller; but the variation as sin 2θ is like that which Miller found, for the harmonic analysis of his results gave a strongly predominant term with period 180°, and the azimuths giving maximum shift showed a fairly strong preference for the north-easterly quadrant; indeed, his observations of June 1, 1925, give an average azimuth of 42°, to be compared with the value of 45° given by the above formula. A small shift with period 360°, on the existence of which Miller insisted, can be explained by a slight inclination of the arms to the horizontal, which yields terms in sin θ and cos θ, omitted from the above formula for the sake of simplicity.

The positive results obtained by Miller have long remained an anomaly because experiments by Joos[2], Kennedy[3], Illingworth[4] and Michelson (with collaborators)[5] gave essentially null results. I suggest as a possibility that the discrepancy between these results and those of Miller may be found in the mountings of the interferometers. Joos supported his instrument on springs and so insulated it mechanically from the earth; the others used flotation on mercury, as did Miller, but Miller used a substantial pin attached to the interferometer and passing loosely through a bearing. This pin is shown by Miller (Fig. 5, *loc. cit.*, p. 208), and I am much indebted to Prof. R. S. Shankland, of the Case Institute of Technology, for further information obtained from the mechanic who worked with Miller.

Although the pin was far from attaching the interferometer rigidly to the earth, it may have provided sufficient constraint to make the interferometer behave, at least partially, as though it were part of the earth itself, and so give us an excuse for taking the earth's centre as drag-point (the most natural point, surely, if we were dealing with the earth itself as a rigid body).

However that may be, the concept of rigid-body motions is important in physics and an adequate theory of these motions is most desirable. It is true that we have the Born–Herglotz theory; but I have been unable to see how that theory leads to any definite prediction regarding the Michelson–Morley experiment performed on the rotating earth. Now that the special theory of relativity is firmly established, we should look on experiments like the Michelson–Morley experiment as experiments on rigid bodies rather than on light propagation. But as a test of Gardner's hypothesis, an interferometer with horizontal arms is very inefficient. When the arms are tilted up, the theory predicts quite a large effect with period 360° in azimuth. Indeed, with one arm inclined to the vertical at 45° and the other horizontal, Gardner's hypothesis predicts a fringe-shift of a full fringe-width with an arm-length of only 20 cm., provided, of course, that the interferometer is firmly mounted on a vertical axis to ensure that it may be regarded as part of the rotating earth and so have the earth's centre as drag-point.

A fuller account of this work will appear in the issue of the *Scientific Proceedings of the Royal Dublin Society* commemorating the centenary of the birth of George Francis Fitzgerald.

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[1] Miller, D. C., *Rev. Mod. Phys.*, **5**, 203 (1933).
[2] Joos, G., *Ann. d. Physik*, [5], **7**, 385 (1930).
[3] Kennedy, R. J., *Proc. U.S. Nat. Acad. Sci.*, **12**, 621 (1926).
[4] Illingworth, K. K., *Phys. Rev.*, **30**, 692 (1927).
[5] Michelson, A. A., Pease, F. G., and Pearson, F., *J. Opt. Soc. Amer.*, **18**, 181 (1929).

Solar Outbursts at 8·5-mm. Wave-length

Sudden large increases in solar radio radiation, characterized by a rapid rise in intensity and a slower fall and usually associated with chromospheric flares, have been observed in the last few years by Hey[1] and others at all frequencies at which solar radiation has been measured, except at the highest frequencies. We can now report the measurement of several outbursts at a frequency of 35,000 Mc./s., or 8·5-mm. wave-length.

In the spring of 1951, a radiometer operating at a wave-length of 8·5 mm. was put in operation at the Naval Research Laboratory, Washington, D.C., and adjusted to follow the sun during the daylight hours and record continuously the intensity of the sun's radiation. Previous work at a wave-length of 8·5 mm.[2,3] had shown that the intensity of the sun's radiation at this wave-length was much more constant than at longer wave-lengths. However, the previous work was done with a highly directive beam, so that only a portion of the surface of the sun was observed at one time.

The radiometer used in the present experiment has an antenna of 24-in. aperture and beam-width of 1·1°; hence the sun is seen as a point source. The object of the experiment was to watch for sudden

Solar Outbursts at 8·5-mm. Wave-length

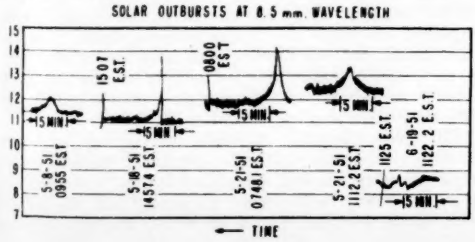
Date	Outbursts			Flares			Sudden ionic disturbance (S.I.D.)	
	λ cm.	Time (U.T.)	Amplitude	Source	Position	Time	Source	Time	Source
8/5/51	0·85 3·14 150	1455 1505 1455	0·055 4·23	N.R.L. N.R.L. Cornell	N. 10° E. 90°	1505–08 1503±2	H.A.O. Mich.	1506–30 1506–30 1510–35	H.A.O. Mich. Mich.
18/5/51	0·85 3·14 65 150 190 600	1957·4 1958·3 2002 1958 1958 1958	0·269 2·50	N.R.L. N.R.L. N.B.S. Cornell N.B.S. N.B.S.	N. 17° W. 35°	1959–2002·5 1956	H.A.O. Mich.	1955–2040 1955–2040 2005	H.A.O. Mich. N.B.S.
21/5/51	0·85 150	1248·1 1247	0·230	N.R.L. Cornell	None			None	
21/5/51	0·85	1612·2	0·075	N.R.L.	N. 14° W. 80°	1610–1700 1609–35	H.A.O. Mich.	1610–30 1610–30	H.A.O. Mich.
19/6/51	0·85 3·14	1622·2 1622·2	0·060 >0·37	N.R.L. N.R.L.	S. 12° W. 18°	1620–28 No obs.	H.A.O. Mich.	1622–1700 1625–1700	H.A.O. Mich.

changes in the intensity of the radiation and to correlate these changes with those observed at 3-cm. wave-length in a similar apparatus at this laboratory, with changes observed at longer wave-lengths at other institutions, and with visual observation of solar flares.

During the period May 1–October 1, five bursts of radiation were found with the 8·5-mm. wave-length apparatus. The times of occurrence of four of the bursts coincide with observed flares, and at the time of the fifth, May 21, 1951, 12h. 48.1m. U.T., there was an active region on the west limb of the sun. Details are given in the accompanying table, where the 8·5-mm. bursts are shown along with data on known bursts at other wave-lengths associated with the same occurrence. The position and time of the associated flare and the time of the associated sudden ionic disturbance (S.I.D.) are given. We are indebted to Miss H. Dodson of the University of Michigan, to the High Altitude Observatory, Cornell University, and to the National Bureau of Standards for making available data used in this table.

The character of the bursts at 8·5 mm. is illustrated in the accompanying record, which is a tracing of the recording milliammeter in the output of the radiometer. Tracings for five outbursts are shown. Zero is at the level of sky noise. Variations in level from day to day are due more to changes in the gain of the receiver than to variations in the solar flux. The width of the trace is indicative of the inherent fluctuation level in the instrument. The burst of May 18 had a time of rise comparable with the time constant of the instrument, 1 sec., whereas the burst of May 8 rose to full amplitude in about 2 min. The times of rise of the other bursts fall between these two extremes. The steadiness of the trace is affected by the presence of clouds. This is most clearly shown in the trace of June 19, where the small rise preceding the burst was due to a change in cloud cover. The 8·5-mm. bursts differ from those at longer wave-lengths in two principal respects: the burst is in general of much shorter duration and the amplitude is much smaller. The largest burst yet observed on a wave-length of 8·5 mm. caused an increase in the total solar radiation of only 27 per cent. The duration of the bursts has all been less than 5 min.

Observation of bursts at very short radio wave-lengths is of interest since presumably the escaping radiation comes from deeper layers of the sun's atmosphere than it does for the longer wave-lengths[3]. The observation of two types of outbursts, one when the time of onset is nearly the same for different wave-lengths, as in the burst of June 19, and the second when the time of onset occurs at later times for longer wave-lengths, has been reported before by several observers[4–9]. The single observation reported here of simultaneity of occurrence at two wave-lengths, 8·5 mm. and 3 cm., is significant in that for this occurrence a transport of material[4–6,8] as the source of burst energy is highly improbable.



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[1] Hey, J. S., *Nature*, **157**, 47 (1946).
[2] Hagen, John P., NRL Report No. 3504 (July 1949).
[3] Hagen, John P., *Astrophys. J.*, **113**, 547 (1951).
[4] Wild, J. P., and McCready, L. L., *Aust. J. Sci. Research* A, **3**, 387 (1950).
[5] Wild, J. P., *Aust. J. Sci. Research*, A, **3**, 399 (1950).
[6] Wild, J. P., *Aust. J. Sci. Research*, A, **3**, 541 (1950).
[7] Christiansen, W. N., and others, *Aust. J. Sci. Research*, A, **4**, 51 (1951).
[8] Ellison, M. A., *Nature*, **167**, 941 (1951).
[9] Covington, A. E., and Medd, W. J., *J. Roy. Astro. Soc. Canada*, **43**, (May–June 1949).

A New Molybdenum Carbide

STUDIES of the products formed by carburizing molybdenum with carbon monoxide have confirmed the existence of Mo_2C (β-phase) and MoC (γ-phase), the latter having the tungsten carbide (WC) structure. But in addition to these two phases, a new carbide (called here the γ′-phase) has been found. The X-ray diffraction lines of this new carbide have not been reported by earlier investigators.

When the carburization takes place at low temperatures, the γ′-phase is the first to be formed after the β-phase. If the γ′-phase is kept at sufficiently high temperatures, either in a stream of carbon monoxide or in vacuum, it transforms (fairly rapidly above approximately 800° C.) into the γ-phase. At high temperatures the γ-phase is evidently more stable than the γ′-phase. The γ-phase may also be the more stable of these two phases at low temperatures, although the speed of the transformation $\gamma' \rightarrow \gamma$ is then very low.

The γ′-phase is hexagonal and the unit cell contains 4 molybdenum atoms. In the accompanying table its dimensions are compared with the dimensions obtained (in our carburization experiments) for the β- and γ-phases.

	β, Mo_2C	γ′	γ, MoC
a (A.)	3·002	2·932	2·898
c (A.)	4·724	10·97	2·809
c/*a*	1·574	3·742	0·9·9
Mo per unit cell	2	4	1
Vol. per Mo (A.^{3})	18·44	20·42	20·42

The space-group is $C6/mmc$ and the molybdenum atoms occupy the position 4(*f*) with $z = \frac{1}{8}$. If the three projections of these positions on the basal plane are designated by *A*, *B*, and *C*, the molybdenum lattice can be symbolized by the sequence *AABBAABB* . . . . In the β-phase (hexagonal close-packed molybdenum lattice) the sequence is *ABAB* . . . and in the γ-phase it is *AAAA* . . . . In this respect the molybdenum lattice of the γ′-phase forms an intermediate stage between the β- and γ-phases. However, no indication of a stacking disorder has been found.

The parameter *z* seems to be very close to $\frac{1}{8}$. This is remarkable, as the distance between layers *A* and *B* is then equal to the distance between layers *A* and *A*. One would expect the former to be smaller.

No signs of definite positions of the carbon atoms have been found. The composition of the γ′-phase could not be based on analyses as the entirely pure phase was never obtained. A comparison of the

lengths of the c axes and the volumes per molybdenum atom of the three phases indicates that the carbon content can scarcely be less than that corresponding to the formula MoC. The fact that the transformation $\gamma' \rightarrow \gamma$ takes place without any other changes in the powder photographs suggests the formula MoC.

A metal lattice similar to that of the γ'-phase has been found by Kiessling[1] for the tungsten boride, W_2B_5. In this case the parameter z is slightly different from $\frac{1}{4}$, namely, 0·139.

A detailed report will be published elsewhere.

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[1] Kiessling, R., *Acta Chem. Scand.*, **1**, 893 (1947).

Preparation and Magnetic Susceptibility of an Oxygen Clathrate Compound

During attempts to prepare samples of β-quinol by the method of Powell and Riesz[1], we observed that the crystals obtained, which gave X-ray powder photographs characteristic of β-quinol, effervesced when dissolved in water. When 1 gm. of a sample of this substance which had been dried *in vacuo* was dissolved in water, 7·9 c.c. (at N.T.P.) of a gas were evolved. This gas contained 28 per cent oxygen, and the rest appeared to be nitrogen. It therefore seems probable that this is an 'air' clathrate[2] compound of β-quinol in which about 12 per cent of the available spaces are filled.

This suggested that an oxygen clathrate compound might be prepared if oxidation of the quinol could be prevented. A warm saturated solution of quinol in air-free alcohol was placed in a monel metal bomb and allowed to cool slowly over a period of about 24 hr., under a pressure of 25–40 atmospheres of oxygen. Faintly yellow crystals were obtained which, when dissolved in water, evolved a gas. The volume of gas obtained corresponded in different samples to clathrate compounds in which 40–50 per cent of the available spaces had been filled. The densities of the samples were consistent with this interpretation. In one case, the gas was analysed and found to contain 97·6 per cent of oxygen.

The magnetic susceptibility of a finely powdered sample was measured, and it was found to be paramagnetic ($\chi = +3{\cdot}31 \times 10^{-6}$ at 17° C.). Analysis of the same sample gave 39·0 per cent of the available spaces filled. Assuming the specific susceptibility[3] of quinol to be $-0{\cdot}604 \times 10^{-6}$, this leads to a value of $\chi = +109{\cdot}5 \times 10^{-6}$ at 17° C. for the oxygen molecules trapped in the spaces. The experimental values for χ for gaseous oxygen range from $104{\cdot}5$ to $110{\cdot}0 \times 10^{-6}$ at 17° C., the theoretical value[4] being $107{\cdot}7 \times 10^{-6}$. This shows that there is very little magnetic interaction between the oxygen molecules in the crystals. The magnetic behaviour of the oxygen molecules at low temperatures might well prove interesting, since they will not have the opportunity of forming loose complexes O_4 as occurs in liquid and solid oxygen. Since the concentration of oxygen molecules in these samples corresponds to gaseous oxygen at a pressure of about 40 atmospheres, the magnetic properties are easy to observe.

A method of preparing pure β-quinol containing no enclosed gases has now been devised in which a warm strong solution of quinol in air-free alcohol is seeded with a crystal of argon clathrate compound and allowed to cool in a refrigerator. Unless it is kept in a very dry atmosphere, pure β-quinol tends to revert to α-quinol.

A more detailed account of these and other measurements on clathrate compounds will appear elsewhere.

We are grateful to Mr. H. M. Powell for carrying out X-ray measurements on the samples of β-quinol, and to Dr. B. Lambert and Mr. A. B. Webster for analysing the gas liberated from the oxygen clathrate compound. We thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (D. F. E.).

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[1] Powell, H. M., and Riesz, P., *Nature*, **161**, 52 (1948), and private communication from Mr. Powell.
[2] Palin, D. E., and Powell, H. M., *J. Chem. Soc.*, 815 (1948).
[3] French, C. M., *Trans. Farad. Soc.*, **41**, 676 (1945).
[4] Selwood, P. W., "Magnetochemistry", 117 (Interscience).

Stabilization of Free Radicals: its Importance in Reaction Kinetics

A previous paper[1] reported on a reaction of the radical chlorine oxide:

$$ClO + O_2 \rightleftharpoons ClO_3 \rightleftharpoons \tfrac{1}{2}\, Cl_2O_6,$$

enabling the transfer of chlorine oxide by means of addition of oxygen into the more stable chlorine trioxide and eventually, at a low temperature, into the stable chlorine hexoxide (Cl_2O_6). Similarly, the discussion[2] of the mechanism of the decomposition of ozone sensitized or catalysed by chlorine points to the fact that chlorine dioxide can also be considered as a chlorine atom stabilized by an oxygen molecule. The process $Cl + O_2 = ClO_3$ is exothermic to an extent of 1·5 kcal., and runs down practically without activation energy[3]. On examining the other cases in which the oxygen atom or molecule behaves in a similar manner, the cases of HO_2, NO and NO_3 radicals are striking. HO_2 and NO_3 are hydrogen and nitrogen atoms stabilized by an oxygen molecule, whereas NO is a stabilized complex from $N^{\cdot}$ and $O^{\cdot}$ and can also be transformed by addition of O_2 into NO_3.

In the mechanisms of organic pyrolyses and oxidation reactions, $R^{\cdot}$ and $R{\cdot}C^{\cdot}$ radicals are also frequently encountered, forming in the presence of oxygen $RO_2^{\cdot}$ or $RCO_3^{\cdot}$, or, in other cases, only with atomic oxygen $RO^{\cdot}$ or $RCO^{\cdot}$ respectively. In the reaction schemes they are considered to be rate-determining, fairly stable, intermediate products[4]. In their halogenated forms, these radicals behave in a similar fashion. They are characterized by all having unpaired electrons and being paramagnetic. On the other hand, radicals having even numbers of electrons do not exhibit analogous behaviour in any instance. Taking numerous other examples into account, the following rule can be established.

The paramagnetic radicals containing unpaired electrons combine with the similarly paramagnetic oxygen atoms as well as with oxygen molecules, or more generally with other paramagnetic molecules, such as nitric oxide, into more or less strongly bonded

complex radicals, thus prolonging the life of the radical.

Obviously the extent of stabilization will be a function of the heat liberated at stabilization. The slight activation energy as well as the small heat of reaction results in a reversible stabilization. On the other hand, if more energy is released on association, the stabilized radical participates more sluggishly in the further process; consequently, stabilization corresponds to the slowing down of the reaction. If the energy liberated at stabilization is very great, the stabilized radical may even exist as a fairly stable compound. Nitric oxide and nitrogen dioxide can be considered to represent such examples.

Considering that the fate of a radical is either the propagation of the chain by reacting with another new molecule or its destruction, stabilization can influence the rate of reaction in different ways. If it preserves radicals which otherwise are disappearing quickly, thus saving them for the subsequent steps of the process, then the stabilization increases the total rate of the reaction.

On the other hand, stabilization of a radical may accelerate the recombination of the radicals, by allowing the reaction:

$$R{\cdot}X + R = R_2 + X,$$

which simplifies the original three-body collision to a bimolecular process. If this recombination removes the chain carriers from the process, it is natural that stabilization should result in the diminution of the velocity of the total reaction.

The variation of the rate of reaction by nitric oxide provides a suitable illustration of reaction kinetics based on these statements. Nitric oxide is paramagnetic and exerts—as proved by the analyses of cases hitherto investigated—an influence only on the rate of chain reactions proceeding by paramagnetic radicals. This influence can be two-fold. If nitric oxide is present only in small amounts, it is not able to stabilize all the chain carriers having odd numbers of electrons, and hence there is a greater possibility for association to occur:

$$R{\cdot}NO + R = R_2 + NO;$$

this is equivalent to the rupture of the chain and so decreases the velocity.

If, on the other hand, the concentration of nitric oxide is greater, it diverts the chain carriers from this association, thus resulting in a positive catalytic action. In the sequence of reactions:

$R + R + M = R_2 + M$ (rupture of the chain)
$R + A = R' + A'$ (propagation of the chain)
$R{\cdot}NO + R{\cdot}NO = R_2 + 2NO$ (rupture of the chain)
$RNO + A = R' + A' + NO$ (propagation of the chain)
$RNO + R = R_2 + NO$ (rupture of the chain),

the activation energies of the processes diminish according to the sequence of the equations. Consequently, a large quantity of nitric oxide preserves the chain carriers from the destruction effected in other ways.

The role of nitric oxide in promoting association becomes also manifest at the recombination of the hydrogen atoms[5]. It can be demonstrated experimentally that the recombination of hydrogen atoms in the presence of nitrogen oxide is far more rapid than in the case of any other three-body collision partners. By intense cooling the product $(HNO)_n$ can be frozen out from the reaction mixture.

In the case of stabilization not being reversible, the complex radical decomposing into other constituents can only effect a decrease of the rate of reaction.

The stabilization of the free radicals is pre-eminently a catalytic process, since it modifies the reaction-rate by means of an intervening substance. We have restricted the possibility of stabilization of the free radicals to paramagnetic ones. Of course, as a consequence of the prolongation of the life of these substances possessing the greatest reactivity, the extent of the reaction increases. This requires the presence of other paramagnetic substances.

From this concept, the rule is not only confined to homogeneous processes, but also may involve heterogeneous ones. The catalysing effect of paramagnetic substances lies in prolonging the life of the most reactive paramagnetic radicals. If a process takes place via free radicals containing even numbers of electrons, the paramagnetic catalysts do not exert any appreciable effect, and conversely a non-paramagnetic catalyst does not influence considerably the rate of a reaction proceeding by paramagnetic radicals. Accordingly, the extent of the surface alone cannot determine the activity of a catalyst. The number of the paramagnetic molecules on the surface is an essential factor. The most effective catalysts are mixed catalysts, in which smaller or larger groups of components have only the role of a supporter promoting the development of the virtual catalyst, the paramagnetic substance, and maintaining its activity.

These facts point to the significance of the magnetic properties of substances in chemical processes, and thus to the role of magnetochemistry in reaction kinetics.

A detailed discussion of this work will be published in English in *Acta Chimica Hungarica*.

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[1] Szabó, Z. G., *J. Chem. Soc.*, 1356 (1950).
[2] Norrish, R. G. W., and Neville, G. H. J., *J. Chem. Soc.*, 1864 (1934).
[3] Bodenstein, M., and Schenk, P. W., *Z. phys. Chem.*, B, **20**, 420 (1933).
[4] Steacie, E. W. R., "Atomic and Free Radical Reactions" (New York, 1946).
[5] Smallwood, H. M., *J. Amer. Chem. Soc.*, **51**, 1985 (1929).

Formation Constants of some Metal-Tropolone Complexes

THE formation constants of several metal derivatives of tropolone have been determined in order to compare the co-ordination tendency of tropolone with that of other co-ordinating groups. The order of stability of the various metal derivatives is $Cu^{II} > Be > Pb > (Zn, Ni) > Co^{II}$. In general, this order agrees with that found for the co-ordination compounds of ammonia[1], ethylenediamine[1,2], salicylaldehyde[1–4], salicylaldehyde-5-sulphonic acid[5], β-diketones[4,6,7], 8-hydroxyquinoline[4], 8-hydroxyquinoline-5-sulphonic acid[8], and α-amino-acids[8,9]. The metal-tropolone compounds are more stable than the corresponding acetylacetone compounds, which may be further evidence of the greater stability of five-membered chelate rings compared to six-membered rings.

Tropolone was synthesized in the manner described by Cook *et al.*[10] (found: m.p., 48–50°; $pK_D = 6{\cdot}97 \pm 0{\cdot}02$ at 30°; reported m.p., 49–50°; $pK_D = 7{\cdot}00 \pm 0{\cdot}2$ at 20°).

Formation constants were determined by the potentiometric method of Bjerrum[11] as modified by Calvin and Wilson[12]. Because of the slight solubility of these complexes in water, all titrations were carried out in a solvent containing 50 per cent dioxane by volume. Determination of the pK_D of tropolone in this medium at an ionic strength approximately equal to that existing in these solutions at the midpoint of the neutralization of excess tropolone yielded a value of 7·92. It was found that the pK_D was very sensitive to slight changes in ionic strength, so for each determination pK_D was taken directly from the titration curve and this value used in the calculation of the formation constants.

Of the six metals discussed here, it was found that three (zinc, nickel and divalent cobalt) were able to co-ordinate with three molecules of tropolone to form a singly charged anion, MCh_3^-, while the other three (divalent copper, beryllium and divalent lead) combine with only two molecules of the tropolone to form neutral species, MCh_2. This behaviour was noted earlier for hinokitiol, β-*iso*propyltropolone[13–15].

The constants were calculated from concentration data, assuming all activity coefficients to be unity.

Metal	log K_1	log K_2	log K_3
Cu(II)		7·83	
Be	8·31	6·93	
Fb(II)	7·88	5·92	
Zn	7·48	6·29	3·44
Ni	7·61	6·03	3·88
Co(II)	7·04	5·71	3·68

Co-ordination with copper was so strong that log K_1 could not be determined.

The low solubilities of the complexes of several of the trivalent metals have introduced difficulties in the determination of their formation constants. Although the formation of complexes has been demonstrated with calcium, strontium and divalent mercury, additional work is necessary to obtain accurate data.

Formation curves for the complexes are shown in Figs. 1 and 2.

Crystalline material was obtained in several instances by partial evaporation of the solutions after titration. The cobalt derivative was a lustrous, reddish violet, and the zinc solution yielded light yellow octahedra. The copper compound was found to decompose at *c.* 300°, whereas the other two compounds were unaffected at temperatures up to 275°.

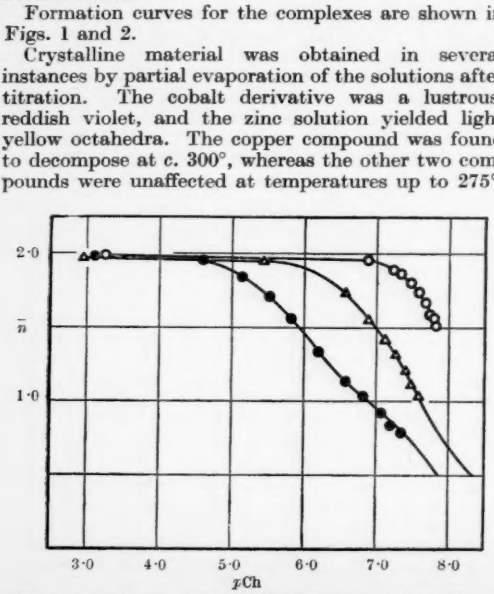

Fig. 1. Formation curves for complexes with copper (○), beryllium (△) and lead (●)

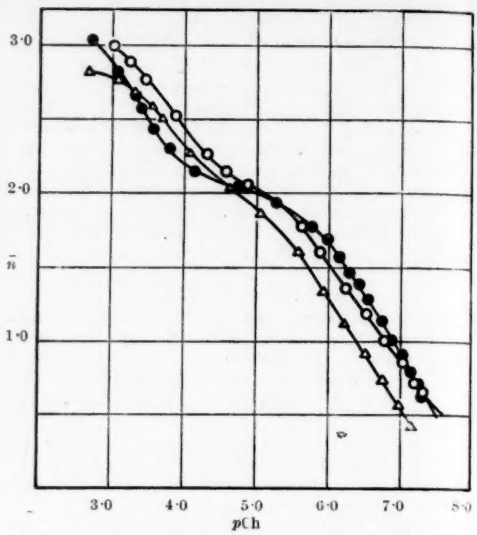

Fig. 2. Formation curves for complexes with zinc (●), nickel (○), and cobalt (△)

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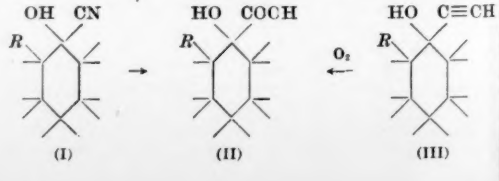
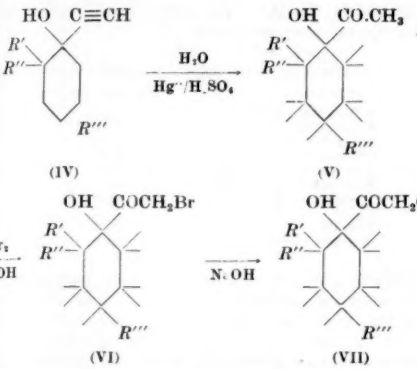
[1] Irving, H., and Williams, R. J. P., *Nature*, **162**, 746 (1948).
[2] Mellor, D. P., and Maley, L., *Nature*, **161**, 436 (1948).
[3] Mellor, D. P., and Maley, L., *Nature*, **159**, 370 (1947).
[4] Maley, L. E., and Mellor, D. P., *Aust. J. Sci. Research*, **2**, 92 (1949).
[5] Calvin, M., and Melchior, N. C., *J. Amer. Chem. Soc.*, **70**, 3270 (1948).
[6] Yamasaki, K., and Sone, K., *Nature*, **166**, 998 (1950).
[7] Van Uitert, L. G., Fernelius, W. C., and Douglas, B. E. (unpublished work).
[8] Maley, L. E., and Mellor, D. P., *Aust. J. Sci. Research*, **2**, 579 (1949).
[9] Maley, L. E., and Mellor, D. P., *Nature*, **165**, 453 (1950).
[10] Cook, J. W., Gibb, A. R., Raphael, R. A., and Somerville, A. R., *J. Chem. Soc.*, 503 (1951).
[11] Bjerrum, J., "Metal Ammine Formation in Aqueous Solution" (P. Haase and Sons, Copenhagen, 1941).
[12] Calvin, M., and Wilson, K. W., *J. Amer. Chem. Soc.*, **67**, 2003 (1945).
[13] Nozoe, T., *Bull. Chem. Soc. Japan*, **11**, 295 (1936).
[14] Iinuma, H., *J. Chem. Soc. Japan*, **64**, 742 (1943).
[15] Iinuma, H., *J. Chem. Soc. Japan*, **64**, 91 (1943).

Simple Analogues of Cortisone

In continuation of previous work from this Department[1], some methyl-substituted analogues of 1-hydroxyacetyl*cyclo*hexanol have now been prepared. The previous method employed an α-hydroxy acid (II, R=H) obtained from its cyanohydrin (I, R = H). 2-Methyl*cyclo*hexanone cyanohydrin



could not be hydrolysed to the corresponding acid (II, $R=CH_3$), and although this acid was obtained by the oxidation of the corresponding 2-methyl-1-ethynyl*cyclo*hexanol (III, $R=CH_3$), the low yields rendered the product unsuitable as a starting material. Hence, for further work the method was modified as follows :



2-Methyl*cyclo*hexanone with sodium acetylide in liquid ammonia furnished excellent yields of the *cis trans* - 2 - methyl - 1 - ethynyl*cyclo*hexanols[2], which were roughly separated into the *cis*- (m.p. 58°, 40 per cent) and the *trans*- (b.p. 76°/15 mm., n_D^{22} 1·4689, 60 per cent) forms by crystallization. Both forms were hydrated with dilute sulphuric acid in the presence of a mercury salt, and the ketones so obtained (V, $R'=CH_3$, $R''=R'''=H$) completely purified at this stage through their semicarbazones (*cis*-2-methyl-1-acetyl*cyclo*hexanol, m.p. 36° ; semicarbazone, m.p. 229–230° ; *trans*-2-methyl-1-acetyl*cyclo*hexanol, b.p. 92°/10 mm., n_D^{18} 1·4635 ; semicarbazone, m.p. 218–219°). Bromination of the respective ketones yielded *cis*-2-methyl-1-bromoacetyl*cyclo*hexanol (VI, $R'=CH_3$; $R''=R'''=H$, m.p. 68–69° ; pyridinium quaternary salt, m.p. 188–190°) and *trans*-2-methyl-1-bromoacetyl*cyclo*hexanol (b.p. 70°/10^{-4} mm., pyridinium salt, m.p. 202–203°).

The corresponding *cis*-2-methyl-1-hydroxyacetyl-*cyclo*hexanol (VII, $R'=CH_3$; $R''=R'''=H$, m.p. 79–80°) and the *trans*-2-methyl-1-hydroxyacetyl*cyclo*hexanol (viscous liquid ; semicarbazone, m.p. 199–201°, and thiosemicarbazone, m.p. 210° (dec.)) were obtained by hydrolysis of the *cis*- and *trans*-bromides.

4-Methyl*cyclo*hexanone gave 4-methyl-1-ethynyl-*cyclo*hexanol (m.p. 20°, evidently a *cis*- and *trans*- mixture from which only very small yields of one pure form, m.p. 36°, could be separated). On hydration, the mixture yielded a ketone (V, $R'=R''=H$; $R'''=CH_3$, b.p. 99–100°/10 mm. ; semicarbazone, m.p. 181–182°). Bromination and hydrolysis further yielded 4-methyl-1-bromoacetyl*cyclo*hexanol (VI, $R'=R''=H$; $R'''=CH_3$, b.p. 125°/0·004 mm.) and 4-methyl - 1 - hydroxyacetyl*cyclo*hexanol (VII, $R'=R''=H$; $R'''=CH_3$, m.p. 80–81°). Similar reactions on 2 : 2 dimethyl*cyclo*hexanone furnished only very small yields of 2 : 2 dimethyl-1-hydroxy-acetyl*cyclo*hexanol (VII, $R'=R''=CH_3$, $R'''=H$, m.p. 56°).

The present method of introducing the dihydroxy-acetone chain into simple compounds allows any desired acylation on the primary and tertiary alcohol functions without resorting to selective acylation, and, as a model, a phosphate of the type (IX) has been prepared (1-acetyl*cyclo*hexyl benzoate, b.p. 124·5°/10^{-4} mm., 2 : 4 dinitro-phenylhydrazone, m.p. 200° ; 1-hydroxyacetyl*cyclo*hexylbenzoate, m.p. 76° ; phosphate (IX), m.p. 80–81°).

Further details of preparations and biological tests will be published elsewhere.

I am indebted to Prof. N. F. Maclagan for suggesting this work and for advice and encouragement throughout it. I am also indebted to the Empire Rheumatism Council and the Standring Research Fund, Westminster Hospital, for financial assistance.

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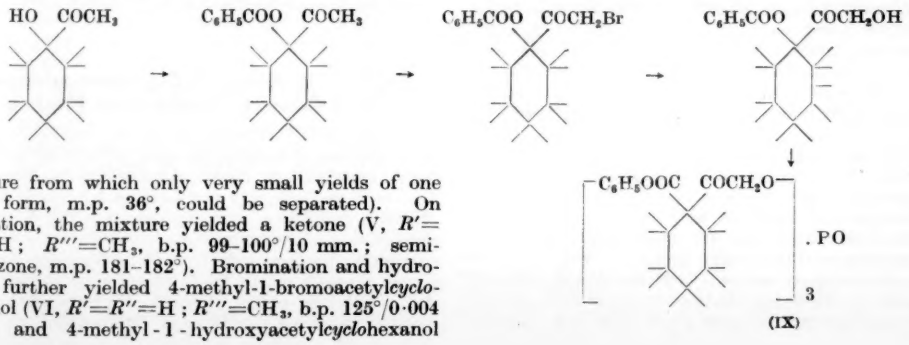
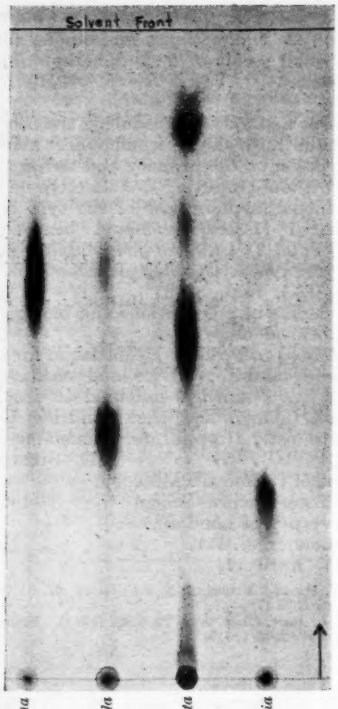
[1] Billimoria, J. D., and Maclagan, N. F., *Nature* **67**, 81 (1951) ; *J. Chem. Soc.*, 3067 (1951).
[2] Milas *et al.*, *J. Amer. Chem. Soc.*, **70**, 1829 (1948). Heilbron *et al.*, *J. Chem. Soc.*, 2023 (1949).

Paper Chromatography of Phenolic Substances

Several recent publications have attested to the utility of the technique of paper partition chromatography in the separation and identification of phenolic substances. Bate-Smith[1] described its application to anthocyanins, flavones and other polyphenolic substances using a butanol – acetic acid – water system and ammoniacal silver nitrate as a detecting reagent. Evans, Parr and Evans[2] used butanol – pyridine – aqueous sodium chloride and diazotized sulphanilic acid (Pauly reagent) to separate and detect simple phenols and their derived phenolic acids. Gosta Lindstedt[3], applying the technique to the separation and identification of nine phenolic constituents of pine heartwood extracts, found that best results were obtained with a water-saturated mixture of benzene and ligroin containing traces of methanol. *Bis*-diazotized benzidine was used as the detecting reagent. A phosphomolybdic acid detecting reagent was used by Riley[4] in applying the technique to





Concentration, 14 mgm./c.c. ; resolved in 3 hr.

common phenols in benzene – alcohol – water systems. In studying lignin degradation products, Hossfeld[5] first coupled the phenol mixtures with diazotized sulphanilic acid and then separated the sodium salts of the dyes formed using a methyl ketone – water system.

In work at the Vancouver Forest Products Laboratory on phenolic extracts of conifer heartwood and phenolic compounds related to lignin, the best results have been obtained using carbonic acid solution alone as a developing solvent, and a fine spray of an aqueous mixture of ferric chloride and potassium ferricyanide as detecting reagent. The latter, easily prepared by mixing equal volumes of one per cent ferric chloride and one per cent potassium ferricyanide a few minutes prior to use, gives an instantaneous deep blue spot similar to Turnbull's blue with all phenols thus far tested. A permanent record is secured by washing the paper with dilute hydrochloric acid followed by water.

The formation of a blue spot by ferric chloride and potassium ferricyanide in the presence of phenols may possibly be explained by the formation of a 1 : 1 complex of ferric ion and phenol, as suggested by Broumand and Smith[6], which then gives the ferrous reaction (Turnbull's blue).

The single-phase carbonic acid developing solvent, prepared by bubbling carbon dioxide through distilled water at 21° C. until a *p*H of 4·2 is reached, gives rapid development (38 cm. in four hours) and good resolution with most phenols.

This simple, but very useful, combination of developing solvent and detecting reagent has been used successfully in this laboratory during the past two years. Results of its application to simple phenols run individually in descending chromatogram on Whatman No. 1 paper at 22° C. are given in the accompanying table. In each case well-defined circular spots were detected.

Distance travelled by some simple phenols in four hours

Substance	Distance (cm.)
α-Naphthol	17·0
β-Naphthol	15·2
Pyrogallol	24·8
Catechol	28·1
Resorcinol	26·0
Phloroglucinol	20·7
Hydroquinone	27·0
Gallic acid	23·6
Vanillin	24·6
Syringaldehyde	20·8

Application to phenols and complex polyphenolics from heartwood extracts is illustrated in the photograph, the chromatograms being, from left to right, those of the acetone extract of mountain hemlock (*Tsuga mertensiana*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and Douglas fir (*Pseudotsuga taxifolia*), respectively. The usefulness of this technique in family and species identification is indicated clearly. The strong spot at R_F 0·26 for the Douglas fir was readily shown by colour tests and comparison with a reference sample to be due to the 3, 3[1], 4[1], 5, 7 pentahydroxy flavanone isolated by Pew[7].

Details of the work on extracts of conifer heartwood will be published elsewhere.

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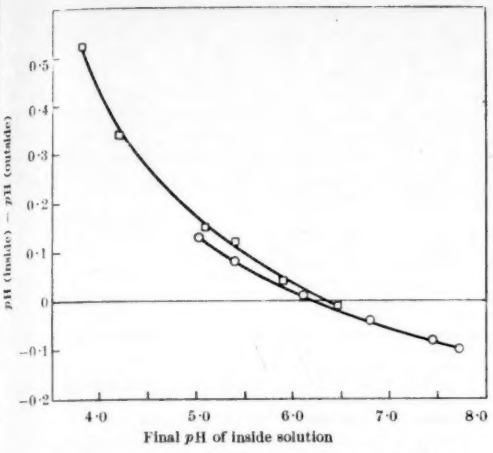
[1] Bate-Smith, E. G., in Biochemical Society Symposia, No. 3. Partition Chromatography (1948). (Cambridge Univ. Press, 1950 ; *Nature*, **161**, 835 ; 1948).
[2] Evans, R. A., Parr, W. H., and Evans, W. C., *Nature*, **164**, 674 (1949).
[3] Lindstedt, G., *Acta Chem. Scand.*, **4**, 448 (1950).
[4] Riley, R. F., *J. Amer. Chem. Soc.*, **72**, 5782 (1950).
[5] Hossfeld, R. L., *J. Amer. Chem. Soc.*, **73**, 852 (1951).
[6] Broumand, H., and Smith, J. H., paper presented at 118th meeting of the American Chemical Society, Chicago, Ill., Sept. 3–8, 1950 (*J. Amer. Chem. Soc.*, **74**, 1013 (1952)).
[7] Pew, J. C., *J. Amer. Chem. Soc.*, **70**, 3031 (1948).

Isoelectric Point of Chymotrypsinogen by a Donnan Equilibrium Method

Kunitz and Northrop[1] found the isoelectric point of crystalline chymotrypsinogen to be near *p*H 5 by their method of microcataphoresis[2]. Recently, Anderson and Alberty[3] and Laskowski[4], using electrophoretic mobilities, gave values of *p*H 9·5 and 9·1 respectively. As it is now possible to crystallize chymotrypsinogen salt free from aqueous alcohol[5], it was thought worth while to attempt to determine the isoelectric point of such a preparation by a method based on the Donnan equilibrium.



□, 8 per cent chymotrypsinogen solution, acetate buffer, 0·004 *M*; ○, 9 per cent chymotrypsinogen solution, phosphate buffer, 0·005 *M*

Chymotrypsinogen was prepared by the method of Kunitz and Northrop[1] and crystallized six times from dilute aqueous alcohol[5]. A 10 per cent solution of the protein in water was prepared with the aid of a few drops of 1 *N* hydrochloric acid; the final *p*H was 3·6. The liquid, which was slightly turbid, was clarified by centrifugation at 5° C. Sodium hydroxide, 1 *N*, was added gradually and samples of 4·0 or 4·5 c.c. were withdrawn from time to time and mixed with 1·0 or 0·5 c.c., respectively, of the appropriate buffer of the same *p*H. Lengths of sausage casing, ¾ in. diameter (Nu Jax Visking cellulose sausage casing, Visking Corp., Chicago), previously washed and each containing a small glass bead, were filled with this solution to such a length that they fitted conveniently into a test-tube. This was filled with the same buffer suitably diluted, so that the concentrations of buffer salts were identical on both sides of the membrane. The initial *p*H of the inner and the outer solutions differed by less than 0·02 *p*H units. The test-tube was then closed with a rubber stopper, leaving a small air-bubble to provide stirring of the outer solution. Several of these tubes were fastened along the radii of a slowly revolving vertical disk and were thus kept stirred for 24 hr. at 5° C. The unopened tubes were allowed to warm to room temperature for 20 min. The *p*H of the outer solution was measured first, followed immediately by measurement of the inner solution.

The graph of the final *p*H of the inner solution against the difference in *p*H between the solutions on the two sides of the membrane is reproduced herewith; the point of zero difference, which is the isoelectric point, is seen to lie at *p*H 6·3. It is interesting to note that the monovalent acetate buffer and the polyvalent phosphate gave almost identical values for the isoelectric point. A similar experiment with veronal–acetate buffer, 0·004 *M*, gave less clear results, but indicated an isoelectric point between *p*H 6 and 7.

This method has the advantage that it can be carried out very simply with a minimum of equipment, provided that the protein is readily available and is stable under the conditions employed. It has none of the disadvantages of the other methods currently in use, except the possibility of combination between protein and the buffer salts; this can, however, be investigated by using diverse types of buffers.

The microcataphoresis[2] of collodion particles coated with chymotrypsinogen gave indications that the protein concentration affects the value of the isoelectric point, higher values being obtained in stronger concentrations. For example, the above preparation of chymotrypsinogen gave a value of *p*H 7·2–7·4 when the concentrations were as high as 0·4–0·8 per cent, $\mu = 0{\cdot}0058$. The state of purity and the previous history of the protein appear also to have an important influence on the result.

I am indebted to Dr. M. Kunitz for his guidance and help and for permission to work in his laboratory. The experiments were carried out during the tenure of a Rockefeller Foundation Fellowship.

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[1] Kunitz, M., and Northrop, J. H., *Science*, **78**, 558 (1933); *J. Gen. Physiol.*, **18**, 433 (1935).
[2] Northrop, J. H., and Kunitz, M., *J. Gen. Physiol.*, **7**, 729 (1925).
[3] Anderson, E. A., and Alberty, R. A., *J. Phys. Coll. Chem.*, **52**, 1345 (1948).
[4] Kubacki, V., Brown, K. D., and Laskowski, M., *J. Biol. Chem.*, **183**, 73 (1949).
[5] Kunitz, M., *J. Gen. Physiol.*, **32** 265 (1948).

Basic Chromosome Numbers in the Genus *Cerastium*

AN investigation of mitotic chromosomes of *Cerastium semidecandrum* L. (British material) has revealed that, of the 36 metaphase chromosomes, four are nucleolar-organizing chromosomes. These each have a satellite. The nucleoli fuse early in telophase since the resting nuclei have only one, two or, more rarely, three nucleoli, though once a cell with four nucleoli was seen. It would thus seem that these $2n = 36$ plants are tetraploid, although no plant with $2n = 18$ has, as yet, been reported, and that nine is finally established as the basic number. From chromosome counts most species in the genus have nine as the basic number; however, there is a group of species, all annuals, which have the chromosome number $2n = 38$. In these plants the nucleolar-organizing chromosomes cannot be distinguished in somatic tissues; but in the pollen-mother cells there are two nucleolar-organizing chromosomes clearly visible during prophase. These two chromosomes each have a distinct deeply staining region in contact with the nucleolus, such as McClintock[1] described in *Zea mays*. It would thus seem that in this section of the genus the plants are truly diploid with 19 as the basic number. A list of species for which chromosome counts are available is given below, with the species grouped according to their basic numbers. Unless otherwise stated the material is continental; undated counts are published here for the first time.

From these lists it is apparent that the majority of the species in the section Orthodon have the basic number 9, while those in the section Strephodon have the basic number 19. A few species, for example, *C. dichotomum*, normally placed in the section Orthodon, would appear from cytological evidence to have a closer relationship with the

$x=9$

Species	2n	Author
C. alpinum L.	72	Böcher, 1938; A. and D. Löve, 1944; Sörensen and Westergaard, 1948; Brett 1950 (Britain).
	168	Sörensen and Westergaard, 1948 (Greenland); Brett, 1950
	c. 144	Brett, 1951
C. arvense L.	72	Rohweder, 1939; Mattick, 1949; Söllner, 1950; Brett, 1951 (Britain)
	36	Söllner, 1950; Brett (Canada)
	38	Brett, 1950
C. banaticum (Roch) Heuff	72	Söllner, 1950
C. brachypetalum Pers.	*c.* 52	Mattick, 1949
	90	Hagerup, 1944; Brett (Britain)
C. cerastoides Britton	36	Mattick, 1949
	38	Favarger and Söllner, 1949
	40	Böcher, 1938; Sörensen and Westergaard, 1948
C. candidissimum Correns	36	Rohweder, 1939
C. fontanum Baumg.	*c.* 120	Mattick, 1949
	c. 144	Böcher, 1938
C. glomeratum Thuil.	72	Rohweder, 1939; Brett, 1951 (Britain)
C. glutinosum Fries.	72	Hagerup, 1944
C. holosteoides Fries.	*c.* 111	Heitz, 1926
(*C. vulgatum* L.)	126	Hagerup, 1944
	136	Brett, 1950 (Britain)
	144	Rohweder, 1939; Mattick, 1944
	136–152	Brett (Britain)
C. latifolium L.	36	Mattick, 1949; Favarger and Söllner, 1949
C. pedunculatum Gaud.	36	Favarger and Söllner, 1949
C. regelli Ostf.	72	Flovick, 1940
C. semidecandrum I	36	Rohweder, 1939; Brett (Britain)
C. tetrandrum Curt.	36	Wulff, 1937; Rohweder. 1939
	72	Brett (Britain)
C. subtetrandrum (Lange) Murb.	72	Hagerup, 1941
C. tomentosum L.	38	Rohweder, 1939
	72	Brett, 1951
C. uniflorum Clairv.	36	Mattick, 1949; Favarger and Söllner, 1949

$x=19$

C. anomalum Waldst. and Kit.	38	Favarger and Söllner, 1949; Brett
C. chloraefolium Fisch. and Mey	38	Rohweder, 1939; Söllner, 1950; Brett
C. dahuricum Fisch.	38	Söllner, 1950; Brett
C. dichotomum L.	38	Brett, 1951
C. maximum	38	Brett (Alaska)
C. perfoliatum L.	38	Brett, 1950; Söllner, 1950

Strephodon species *C. perfoliatum*. It would also appear, as Söllner[2] has already suggested, that the Dichodon species *C. anomalum* is related to *C. perfoliatum* and, in my opinion, to *C. dichotomum* also. Further investigation it is hoped will result in a more natural classification than that formulated by Seringe and published originally by de Candolle[3].

Other counts in these lists call for comment. Three species, *C. cerastoides*, *C. arvense* and *C. tomentosum*, appear to have both basic numbers. The morphological and geographical evidence would suggest that they belong to the $x = 9$ group and possibly, therefore, the 38 and 40 chromosome members are aneuploids, $4x + 2$ and $4x + 4$.

The species *C. holosteoides* (*C. vulgatum*) is peculiar in that its chromosome number is not constant even for the offspring of the same plant after selfing. This species is a very high polyploid, probably 16-ploid, and it would seem that, at this degree of ploidy, loss or gain of a few chromosomes at meiosis has little if any effect upon the viability and fertility of the seed. The range of chromosome numbers given as 136–152 is probably wider than this, as approximate counts have been made which indicated even lower and higher numbers. Many multivalents are found at first metaphase, and it is thought that different numbers pass to the poles at first anaphase. Lagging chromosomes, though found, are by no means the rule, and usually all the chromosomes are included in one of the four nuclei at the end of meiosis.

The question of the origin of these two basic numbers remains. It is possible that their origins are quite distinct; but, alternatively, it could be that as a result of hybridization the plants with 38 chromosomes have the activity of all but two of their nucleolar-organizing chromosomes suppressed, the situation being similar to that discovered by Nevashin[4] in *Crepis*.

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[2] Söllner, R., *Experientia*, **6**, 335 (1950).
[3] de Candolle, P. de, "Prodromus Systematis Naturalis regni vegetabilis", pars prima, 414 (1824).
[4] Nevashin, M., *Cytologia*, **5**, 169 (1934).

Colonization of Plant Debris by *Coprinus* Species in Soils

Isolation of members of the group Basidiomycetes, as compared with other soil fungi, directly from soil by either the soil dilution plate[1] or the root burial technique[2] has met with little success, though better results have been obtained by the soil plate technique[3]. Hitherto, studies on their distribution were mostly confined to the recording of fructifications (which may be of seasonal occurrence) in Nature[4]. However, in the course of investigations in this laboratory on survival of *Macrophomina phaseoli* by the root burial technique in Madras garden soil amended with ammonia at different concentrations (2, 5 and 10 per cent), it was observed that a Basidiomycete regularly colonized and produced fructifications on pieces of cotton root when plated on agar media (potato-dextrose and Horne and Mitters's media). The incubation period needed in the soil for this colonization was only two weeks. The control pieces of root buried in untreated soil failed to yield the fungus. This work was extended to cotton-growing soils, namely, Coimbatore, Udamalpet and Kovilpatti soils (Madras State). In all cases similar fructifications were observed only in the soils treated with ammonia. This Basidiomycete was also found to colonize and produce its fructifications on pieces of root soaked in 50 per cent ammonia solution for one hour and incubated for one week in the above-mentioned soils. The fungus has been identified as a species of *Coprinus*.

I am indebted to the Director, Royal Botanic Gardens, Kew, for the identification of the Basidiomycete, and to Prof. T. S. Sadasivan, for help and guidance during this investigation. My thanks are due to the Government of India for the award of a Junior Research Scholarship.

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[1] Waksman, S. A., "Principles of Soil Microbiology", 37 (Williams and Wilkins Co., Baltimore, 1932).
[2] Sadasivan, T. S., *Ann. App. Biol.*, **26**, 497 (1939). Subramanian, C. V., *Proc. Ind. Acad. Sci.*, B, **31**, 67 (1950).
[3] Warcup, J. H., *Nature*, **166**, 117 (1950).
[4] Parker-Rhodes, A. F., *New Phytol.*, **50**, 227 (1951).

Filarial Infections in Mosquitoes

MOSQUITOES which on dissection show infective filarial forms are often regarded as vectors of human filariasis in a particular area where mosquito collections are made. As mosquitoes of the same species may also play the part of vectors of animal filarial infections, findings in any given area have to be interpreted carefully. A short account of conditions pertaining in a small village in Sakhigopal, Orissa State, India, where *Wuchereria bancrofti* is the known cause of filarial infection in man, is given below.

Of 3,307 *Culex fatigans* and 1,928 *Mansonioides annulifera* dissected locally, 55 of the former and 41 of the latter were found with infective larval forms in the head/proboscis. In addition, some *M. annulifera* showed microfilariæ or their developing forms in the Malphigian tubes. In view of the fact that *M. annulifera* are not suitable for transmission of *W. bancrofti* and that *Wuchereria* develop in thoracic muscles[1], the possibility of filariæ of other origins existing in the same area was explored. Infective larvæ dissected out from *C. fatigans* were longer than those noted in *M. annulifera*. The former had more than one caudal protuberance, indicating that they were probably *Wuchereria*.

Precipitin tests of blood-meals of mosquitoes were carried out to determine the sources of blood. They showed a higher predilection of *C. fatigans* for human blood than *M. annulifera*, which fed mainly on domestic animals and birds.

Four out of forty dogs examined were found positive for microfilariæ, morphologically similar to *Dirofilaria repens*.

Separate batches of clean *C. fatigans* and *M. annulifera* were allowed to feed on dogs showing *D. repens* infection, and on human cases with *W. bancrofti*. Results showed that a high percentage of *M. annulifera* became infective with *D. repens* but were refractory to infections with *W. bancrofti*. On the other hand, *C. fatigans* showed high susceptibility to infections with *W. bancrofti* and definite refractoriness to development of *D. repens* in them. These points serve to bring out the importance of correct diagnosis of infective forms of filarial infections in mosquitoes.

M. annulifera has been incriminated as a vector for *D. repens*.

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Delhi. Feb. 14.

[1] Iyengar, M. O. T., *Ind. Med. Res. Memoir*, **30** (1938).

Abnormal Leaves of *Cycas revoluta* Thunb.

DURING the course of an investigation on the disposition of xylem in the rachises of cycads, I came across a peculiar abnormality in *Cycas revoluta* Thunb. In some female specimens, several leaves possessed a subsidiary rachis which bore subsidiary pinnæ in a spiral fashion. This was noted in several successive whorls.

Each subsidiary rachis appeared to originate by a conspicuous fold of the main rachis. It was filled mainly by parenchyma. The sides were composed of a lignified epidermis and one to two layers of thick-walled hypodermal cells. The epidermis was heavily cutinized, but was interrupted by sunken stomata

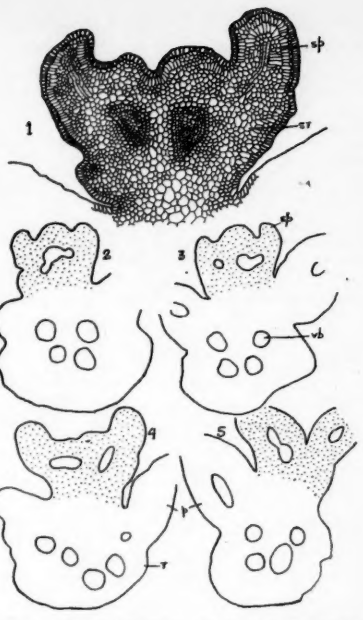

Fig. 1. A part of the transverse section of rachis showing the vascular bundle of subsidiary rachis in division. (× 44)

Figs. 2–5. Changes in the outline of the rachis during the emergence of subsidiary pinnæ. (× 12)
p, Normal pinnæ; *r*, principal rachis; *sp*, subsidiary pinnæ; *sr*, subsidiary rachis; *vb*, vascular bundles

of the normal type. There was a layer of palisade tissue immediately below the epidermis at several places; but its disposition was not uniform (Fig. 1). The vascular bundle was mesarch and included in the inner margin of the rachis. The subsidiary rachis was observed only in the distal half of the leaf, and did not exceed 7 cm. in length.

The subsidiary leaflets were formed by lateral elongation of the rachis and the constriction of the newly formed parts. Each leaflet had the normal structure; but the vascular tissue was very scanty. The transfusion tissue was formed by gradual thickening and elongation, from a mass of loose cells in the rachis which appeared while the leaflet primordium was yet being formed. The vascular bundle of the subsidiary pinna was diffuse at the origin but gradually assumed concentric and then mesarch structure[1].

In an examination of the successive stages of the origin of the subsidiary pinnæ (Figs. 2–5), it was found that the subsidiary rachis lost its identity as the pinnæ matured. The normal structure of the principal rachis was regained by a gradual suppression of the subsidiary rachis and disappearance of its vascular bundle.

Such a feature is unknown in other cycads and has not been reported hitherto as a normal occurrence in *Cycas*.

I am grateful to Prof. Shri Ranjan for his encouragement, and to Mr. G. P. Agarwal and Mr. B. B. S. Raizada for help in the preparation of sections.

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Feb. 10.

[1] Srivastava, R. K., *Proc. Nat. Acad. Sci. (India)*, (in the press).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

BIOCHEMIST (fully qualified with training and experience in hospital laboratories)—The Superintendent, Hope Hospital, Salford 6 (August 16).

ASSISTANT IN MATHEMATICS—The Secretary, The University, Edinburgh (August 21).

ASSISTANT IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, The University, Edinburgh (August 23).

ASSISTANT PROFESSOR IN THE PHYSICS AND ELECTRICAL ENGINEERING DEPARTMENT—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (August 23).

CHEMIST (with honours degree in chemistry or A.R.I.C. and post-graduate analytical and research experience) at the Central Laboratory at County Hall—The Medical Officer of Health (PH/D.1), London County Council, County Hall, London, S.E.1 (August 23).

LECTURER IN PHYSIOLOGY AND PHARMACOLOGY in the School of Pharmacy—The Principal, Technical College, Dundee (August 23).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Sheffield (August 23).

SENIOR LECTURER IN METALLURGY (with a wide knowledge of the metallurgical industry, with detailed knowledge of at least one branch of importance locally) in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Educational Committee, Education Offices, North Street, Wolverhampton (August 23).

HEAD OF THE DEPARTMENT OF SCIENCE (comprising chemistry, physics, biology, mathematics)—The Principal, College for Further Education, Wellington Road South, Stockport (August 27).

PLANT PHYSIOLOGIST (with a good honours degree in botany, with special reference to plant physiology, and preferably some post-graduate experience) under the Colonial Development Welfare Cocoa Research Scheme, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 29).

SOIL CHEMISTS AND SOIL SURVEYORS (with a good honours degree in chemistry (or geology for soil surveyors) and, preferably, some postgraduate experience) under Colonial Development and Welfare Research Schemes for Soils and for Cocoa, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 29).

ASSISTANT IN THE DEPARTMENT OF ANIMAL HUSBANDRY AND PREVENTIVE MEDICINE in the University Veterinary School—The Assistant Secretary of University Court, The University, Glasgow (August 30).

ASSISTANT LECTURER IN GEOLOGY (with special qualifications in petrology)—The Registrar, The University, Sheffield (August 30).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF ELECTRIC POWER ENGINEERING—The Registrar, The University, Liverpool (August 30).

OPERATIONAL RESEARCH POSTS IN THE FIELD INVESTIGATION GROUP of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/511 (August 30).

RESEARCH OFFICER (with an honours degree in zoology or agricultural science, or equivalent, with first-hand experience in the conduct of field ecological investigations on either mammals or birds) IN THE WILDLIFE SURVEY SECTION of the Commonwealth Scientific and Industrial Research Organization, either at headquarters at Canberra or at the field station at Albury, N.S.W., to undertake field ecological studies of mammals and birds of economic importance—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3925 (August 30).

TEACHER OF CHEMISTRY, and a TEACHER OF PHYSICS, to undertake part-time teaching of intermediate standard—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 31).

EXAMINERS IN CHEMISTRY AND PHYSICS, BIOLOGY (Botany and Zoology), PHYSIOLOGY (including Biochemistry) OF THE DOMESTICATED ANIMALS, HISTOLOGY AND EMBRYOLOGY, ANIMAL MANAGEMENT, ANATOMY OF THE DOMESTICATED ANIMALS, PHARMACOLOGY, MATERIA MEDICA AND PHARMACY, VETERINARY HYGIENE, DIETETICS AND ANIMAL HUSBANDRY, VETERINARY PATHOLOGY, VETERINARY PARASITOLOGY, VETERINARY MEDICINE, VETERINARY SURGERY—The Registrar, Royal College of Veterinary Surgeons, 9–10 Red Lion Square, London, W.C.1 (September 1).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, mathematics or physics, or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a small team on work initially concerned mainly with the general field of stress analysis, both analytical and experimental, and later including vibration and photo-elasticity—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4159/52 (September 4).

RESEARCH OFFICER—PHYSICAL CHEMIST (with University honours degree in physics or chemistry, or equivalent qualification) IN THE DIVISION OF FOOD PRESERVATION AND TRANSPORT at the University of Sydney, for studies in the physical chemistry of proteins—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3932 (September 6).

LECTURER IN PHYSICS at University College, Dundee—The Secretary, The University, St. Andrews (September 8).

UNIVERSITY GRADUATE (with first- or second-class honours in botany, with qualifications in mycology) IN THE MICROBIOLOGICAL SECTION of the Department of Soil Organic Matter—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (September 12).

EXPERIMENTAL OFFICERS at the Atomic Energy Research Establishment, Harwell, for mechanical engineering experimental and developmental work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.209/52A (September 13).

LECTURER or ASSISTANT LECTURER IN BIOCHEMISTRY—The Registrar, The University, Sheffield (September 13).

UNIVERSITY LECTURER IN PHILOSOPHY OF SCIENCE—Mr. L. M. Harvey, The Old Schools, Cambridge (September 14).

LECTURER, Grade II (graduate in pure or applied science or its equivalent, with bacteriology as a major subject) IN PATHOLOGY at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

PRINCIPAL SCIENTIFIC OFFICER and a SENIOR SCIENTIFIC OFFICER at a Ministry of Supply Experimental Flying Establishment near Salisbury : PRINCIPAL SCIENTIFIC OFFICER (engineer or physicist with mathematical ability or an applied mathematician with a practical outlook) to control staff engaged mainly in research and development of flight testing methods and techniques ; SENIOR SCIENTIFIC OFFICER (engineer, physicist or applied mathematician with some experience in aeronautical research) to undertake theoretical and analytical work on the development of helicopter testing techniques and general research on helicopter flight problems—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4160/52 (September 25).

SENIOR LECTURER IN GENERAL CHEMISTRY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

ASSISTANT (Grade A or B according to qualifications and experience) IN THE MATHEMATICS DEPARTMENT—The Principal, Derby Technical College, Normanton Road, Derby.

ASSISTANT LECTURER IN NATURAL PHILOSOPHY—The Secretary, Royal Technical College, Glasgow.

ASSISTANT LECTURER, Grade B (with a University degree) to teach botany and zoology at intermediate standard and physiology and anatomy for ophthalmic optics—The Principal, West Ham College of Technology, Romford Road, London, E.15.

BIOCHEMIST (with an appropriate science degree or the A.R.I.C.) IN THE DEPARTMENT OF PATHOLOGY—The Group Secretary, Royal Infirmary, Bolton.

CHEMISTS (Principal Scientific Officer or Senior Scientific Officer grade) at Ministry of Supply London headquarters : duties include the initiation and progressing of research and development on textiles for Service purposes—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.533/52A.

CHEMISTS and CHEMICAL ENGINEERS (Senior Scientific Officer grade) at Ministry of Supply London headquarters for work concerned with guided weapons : (*a*) to sponsor the development and exploitation of new materials, structures, and technical development for engineering processes (Ref. F.519/52A) ; (*b*) to assess the relative performance of different propellants and warheads under service conditions and to progress and assist development work on them (Ref. F.520/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL ENGINEERS and PHYSICISTS (with a first- or second-class honours degree or equivalent in electrical engineering or physics) (Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.302/52A.

JUNIOR ANALYST (with good experience in metallurgical analytical work)—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

MYCOLOGIST (with rank of Assistant Professor) IN THE BOTANY DEPARTMENT—The Chairman, Department of Botany, McGill University, Montreal 2, Canada (apply by airmail).

RESEARCH ENGINEER (B.Sc. or equivalent, and some engineering workshop and drawing office experience essential) for design and testing of experimental equipment—The Assistant Secretary (Ref. A.19), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry, physics or chemical engineering) at the Food Investigation's new Humber Laboratory, Hull, to carry out research in physical and physico-chemical problems on the preservation of fish by smoking, drying, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.303/52A.

SENIOR PHYSICIST (with experience in medical physics) for Radiotherapy Service of the Southampton area—The Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton.

SENIOR SERVICES ENGINEER in the Division of Atomic Energy (Production), Capenhurst Chester, to be directly responsible to the Chief Factory Engineer for all the engineering services (electrical, civil, mechanical) and the associated workshops required in the operation and maintenance of a large chemical engineering factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 358.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research and Fire Offices' Committee. Fire Research Special Report No. 1 : The Heating of Panels by Flue Pipes. By D. I. Lawson, L. L. Fox and C. T. Webster. Pp. vi+41+4 plates. (London : H.M. Stationery Office, 1952.) 2*s.* 6*d.* net. [125

Colonial Geological Surveys : Mineral Resources Division. Vermiculite. By Dr. E. R. Varley. Pp. iv+70. (London : H.M. Stationery Office, 1952.) 7*s.* 6*d.* net. [135

Units and Standards of Measurement employed at the National Physical Laboratory. 2 : Light ; Photometry, Colorimetry and Radiometry. Pp. 8. (London : H.M. Stationery Office, 1952.) 6*d.* net. [145